# Table of contents


***Table of contents*** ..... ***1***

***A Word from the Director*** ..... ***3***

***Presenting the CRM*** ..... ***5***

***Personnel*** ..... ***6***

***Scientific Personnel*** ..... ***7***

Members ..... 7
Postdoctoral Fellows ..... 8
Visitors ..... 10

***Management*** ..... ***12***

Bureau ..... 12
Advisory Committee ..... 12
Computer Facilities ..... 13

***Scientific Activities*** ..... ***14***

Theme Year 2000-2001: Mathematical Methods in Biology and Medicine ..... 14
Aisenstadt Chair ..... 24
General Programme 2000-2001 ..... 27
CRM Prizes ..... 32
Members' Seminars & Special Events ..... 36
CRM-ISM Colloquium ..... 40

***World Mathematical Year*** ..... ***41***

***Coming Events*** ..... ***43***

Theme Year 2001-2002: Groups and Geometry ..... 43
General Programme 2001-2002 ..... 47
Theme Year 2002-2003: Mathematical Methods of Computer Science ..... 50
General Programme 2002-2003 ..... 54
Theme Year 2003-2004: Geometric and Spectral Analysis ..... 56

***Collaborations*** ..... ***59***

***Industrial Mathematics*** ..... ***64***

***Awards, Distinctions, and Landmarks*** ..... ***68***

***Research Programmes*** ..... ***69***

***Publications*** ..... ***85***

Recent Titles ..... 85
Previous Titles ..... 86
Research Reports ..... 89

***Financial Report*** ..... ***92***

Financial Statements 2000-2001 ..... 95

# A Word from the Director

Each year at the CRM brings its own memorable event, which remains in the mind long after the bustle of the year is over. Last year's was the marriage of two participants at a CRM Summer School.

This year, the image that remains is that of the CRM staff preparing for RECOMB. This international meeting in genomics was hosted at the CRM in 2001, and the attendance of over 600 was double that of the previous year. The logistics were quite daunting, and had several rooms full to the ceiling with books, folders, programs and all the miscellaneous conference paraphernalia. Needless to say, the event was a great success, and went off without a hitch. (The *needless* is obvious to all those who have worked with Louis Pelletier and Josée Laferrière, our scientific activities staff).

The whole year was evidence of the explosive growth in the whole area of Mathematical Biology, the theme of the year. There were 1500 participants to the various activities, including more than 700 graduate students and postdoctoral fellows. The program included a Summer School on Nonlinear Dynamics in Biology and Medicine, two large International Annual Meetings (CPM 2000 and RECOMB), eleven 1-week workshops, and six courses and seminars. The holders of the Aisenstadt Chairs represented well the two main thrusts of the year, modelling of physiological processes, and inference techniques in genomics: Arthur Winfree spoke on *Vortices in Motionless Media*, and Michael S. Waterman lectured on *Mathematics for Reading and Understanding Genetic Sequences*. My thanks are due to the organisers of the year, Leon Glass, Brian Golding, Leah Keshet, Keith Worsley and most particularly Jacques Bélair and David Sankoff.

The current year's thematic activities on Groups and Geometry have already started, with one very successful event in June on Groups and Low-Dimensional Topology, run with great ability by Steve Boyer and Dani Wise. There were two workshops, with a week of short courses in between. The event attracted over one hundred and twenty participants for the whole period, with over seventy students. The rest of the year is underway, with a particularly vigorous period extending from next April to June of next year. It starts with two-week session on invariant theory being organised by our colleagues at Queen's and continues in Montreal with an intense period on the Langlands program, the Canadian Number theory conference, and two workshops on the interaction of algebraic geometry and Lie theory. It will also overlap with the start of the following year, on the Mathematics of Computer Science, so the place should be rather busy.

The year was fairly eventful on the industrial front. The area of imaging is one which has seen considerable growth, with the CRM's group being involved with two large scale imaging initiatives, one at the Université de Montréal and the other at McGill, as well as developing its links with the research group at the Pitié-Salpétrière. One recent development is the opening of a spin-off company by one of the group's students. Also, the MITACS research network held its annual meeting in Montreal, which was well attended, and followed by a one week *Spring School* in Optimisation, ably put together by Patrice Marcotte and organised through the CRM, with over a hundred in attendance.

The Network for Computing and Mathematical Modelling, which is run at the CRM, has seen several interesting new developments, including a new large laboratory run with Environment Canada, the Laboratoire Universitaire sur le Temps Extrême (LUTE), the development of a joint initiative with Minnesota's IMA, and the incorporation of the University of Montreal's new representative of the National Research Council's Industrial Research Assistance Program (IRAP) within the CRM. The LUTE is a particularly exciting new development, with an investment of $300K per year, the placing of five Meteorological Service of Canada research staff in a university environment, and the allocation of important amounts of computer time at Canada's largest computing facility at Dorval. The laboratory's official opening will be on the 6th of December.

The year 2000 was UNESCO's World Mathematical Year, and the CRM did its share in the organising of activities to underline the occasion. Our leader in this respect was Stephane Durand, who assembled a thirty-six-page insert for Québec Science on mathematics, aimed at a general scientific audience. He also designed a beautiful series of posters that won the European Mathematical Union's contest. These then appeared in seven different countries. They are still in considerable demand. We have reproduced them below, which give the report a much-needed touch of colour.

The whole process of renewal of our local mathematics community proceeds apace, with the appearance on the scene of dynamic and vigorous new colleagues, who were welcomed with open arms and are already well involved in our activities. Mathematical institutes have become a instrument of preference for the development of a mathematical community, and it is a role that the CRM has played with enthusiasm for many years, and, it is hoped, for many years to come.

*Jacques Hurtubise*

# 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), by 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 carries on its mission and national mandate in several ways:

- it organizes a series of scientific events each year, around a given theme (distinguished lecture series, workshops, conferences, summer schools, visitor programmes, etc.);
- its general programme provides funding for conferences and special events at CRM and across the country;
- each year it invites, through the Aisenstadt Chair, one or two distinguished 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 34 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. One example is the MITACS project (Mathematics of Information Technology and Complex Systems.) Another example is the National Programme Committee, which provides funding for off-site research activities.

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

- the CRM supports, through partnership agreements, a group of local researchers chosen mainly from departments of mathematics and statistics, but also computer science, physics, economics, engineering, etc.;
- it organizes series of regular seminars and lecture courses on different areas of mathematical sciences;
- it sponsors joint activities with the ISM (Institut des sciences mathématiques) including the weekly CRM / ISM colloquium, graduate courses offered by distinguished visitors and a programme of postdoctoral fellowships;
- it 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 ($nc\mathit{m}_2$). This network is funded by NSERC and about 20 partners such as financial institutions, high-tech companies and government agencies.

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 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.

# Personnel

### *The Director's Office*

| | |
|---|---|
| **Jacques Hurtubise** | ***Director*** |
| **Jean LeTourneux** | ***Deputy Director, Publications*** |
| **Christian Léger** | ***Deputy Director, Scientific Program*** |
| **Yoshua Bengio** | ***Deputy Director, Industrial Program*** |
| **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*** |

### *Publications*

| | |
|---|---|
| **André Montpetit** | ***TeX Expert (1/2 time)*** |
| **Louise Letendre** | ***Technician*** |
| **Diane Brulé-De-Filippis** | ***Secretary*** |

### *Computer Services*

| | |
|---|---|
| **Daniel Ouimet** | ***UNIX Systems Manager*** |
| **André Montpetit** | ***Office systems manager (1/2 time)*** |

### *Communications*

| | |
|---|---|
| **Suzette Paradis** | ***Communications officer (1/2 time)*** |

### *MITACS/MaTISC*

| | |
|---|---|
| **Nicole Huron** | ***Administrative Assistant*** |

# Scientific Personnel

**Since its foundation in 1969, the CRM has been involved in a wide variety of research in mathematics as reflected by the spectrum of the research interests of its members, including the CRM's permanent research staff, members attached to the CRM through exchange agreements with neighboring universities and industries, and long-term visitors. The presence at CRM of such an active group of researchers has brought many benefits to the centre. In particular, the CRM's national programme is greatly facilitated by having on hand a large reserve of willing organizers, who have even contributed financially to the organization of activities. The largest partnership is with the Université de Montréal, which gives the equivalent of 5 full-time teaching positions in release time to the CRM. Release agreements with the other Montréal area universities provide for the equivalent of two more full time positions. Facilities are also provided to researchers attached to junior colleges. Several members are attached to the CRM through industrial agreements with Lockheed Martin.**

## Members

***Ali, Syed Twareque***
Math. & stat., U. Concordia

***Beaulieu, Liliane***
Collège Rosemont

***Bélair, Jacques***
Math. & stat., UdeM

***Benali, Habib***
INSERM, France

***Bengio, Yoshua***
DIRO, UdeM

***Bergeron, Nantel***
Math. & stat., U. York

***Bilodeau, Martin***
Math.& stat., UdeM

***Boyarsky, Abraham***
Math.& stat., U. Concordia

***Boyer, Steven***
Math., UQAM

***Broer, Abraham***
Math. & stat., UdeM

***Brunet, Robert***
Math. & stat., UdeM

***Clarke, Francis***
Univ. de Lyon

***Crépeau, Claude***
École d'informatique,
U. McGill

***Darmon, Henri***
Math. & stat., U. McGill

***Delfour, Michel***
Math. & stat., UdeM

***Dufresne, Daniel***
Math. & stat., UdeM

***Durand, Stéphane***
Collège Édouard-Montpetit

***El-Mabrouk, Nadia***
DIRO, UdeM

***Fournier, Richard***
Collège Dawson

***Frigon, Marlène***
Math. & stat., UdeM

***Gagnon, Langis***
Lockheed Martin Canada

***Gander, Martin***
Math. & stat., U. McGill

***Gauthier, Paul***
Math. & stat., UdeM

***Gora, Pawel***
Math. & stat., U. Concordia

***Goulard, Bernard***
Physique, UdeM

***Grundland, Michel***
Math., UQTR

***Harnad, John***
Math. & stat., U. Concordia

***Hurtubise, Jacques***
Math. & stat., U. McGill

***Jakobson, D.***
Math. & stat., U. McGill

***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

***Lesage, Frédéric***
Lockheed Martin Canada
& CRM

***Lessard, Sabin***
Math. & stat., UdeM

***LeTourneux, Jean***
Physique, UdeM

***Lina, Jean-Marc***
CRM, UdeM

***McKay, John***
Math. & stat., U. Concordia

***Meunier, Jean***
DIRO, UdeM

***Nekka, Fahima***
Faculté de Pharmacie, UdeM

***Patera, Jiri***
Math. & stat., UdeM

***Perron, François***
Math. & stat., UdeM

***Pichet, Claude***
Math., UQAM

***Rogers, Colins***
U. New South Wales,
Australia

***Rosenberg, Ivo***
Math. & stat., UdeM

***Rousseau, Christiane***
Math. & stat., UdeM

***Rousseau, Pascale***
Math., UQAM

***Roy, Roch***
Math. & stat., UdeM

***Sankoff, David***
Math. & stat., UdeM

***Schlomiuk, Dana***
Math. & stat., UdeM

***Shahbazian, Elisa***
Lockheed Martin Canada

***Stern, Ronald***
Math. & stat., U. Concordia

***Toth, John***
Math. & stat., U. McGill

***Valin, Pierre***
Lockheed Martin Canada

***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 plays host to a number of postdoctoral fellows. The sources for their funding include the NSERC postdoctoral programme, the NATO international programme administered by NSERC, the CRM (alone or with the ISM or the Fields Institute), and individual research grants from CRM's members. The list below includes only post-doctoral fellows in residence at CRM or funded or co-funded by CRM, with their funding source given in brackets. For 2000-2001, the following fellows were in residence:**

***Aguiar, Marcello***
Cornell Univ.
(CRM-ISM)

***Amblard, Cécile***
Institut National Polytechnique de Grenoble
(CRM-nc$m_2$)

***Allen, Steve***
Univ. de Sherbrooke
(nc$m_2$-Lockheed Martin)

***Bertola, Marco***
S.I.S.S.A.
(CRM-ISM)

***Brightwell, Mark***
Univ. of Glasgow
(CRM-ISM)

***Buono, Luciano***
Univ. of Warwick
(NSERC)

***Corteel, Sylvie***
Univ. Paris-Sud
(CRM-ISM)

***Deteix, Jean***
Univ. de Montréal
(nc$m_2$)

***Fowler, Thomas***
Georgia Institute of Technology
(CRM-ISM)

***Hagedorn, Thomas***
Harvard Univ.
(Sloan Foundation)

***Klucznik, Michael***
Brandeis Univ.
(CRM)

***Loutsenko, Igor***
Univ. de Montréal
(nc$m_2$)

***Polterovich, Iosif***
Moscow State Univ.
(CRM-ISM)

***Sikora, S. Adam***
Univ. de Maryland
(CRM-ISM)

***Tokeida, Tadashi***
Princeton Univ.
(CRM)

**For 2001-2002, the list comprises:**

***Allen, Steve***
Univ. de Sherbrooke
(nc$m_2$-Lockheed Martin)

***Bertola, Marco***
S.I.S.S.A.
(CRM-ISM)

***Brightwell, Mark***
Univ. of Glasgow
(CRM-ISM)

***Buono, Luciano***
Univ. of Warwick
(NSERC)

***Casesnoves, Raquel***
Univ. de Montréal
(CRM)

***Chapoton, Frédéric***
Paris VI
(LaCIM-CRM)

***Dai, Jack Jie***
Iowa State Univ.
(CRM-ISM)

***Langerman, Stefan***
Rutgers Univ.
(CRM-McGill)

***Loutsenko, Igor***
Univ. de Montréal
(nc$m_2$)

***Maillot, Sylvain***
Univ. Paul Sabatier
(CRM)

***Matessi, Diego***
Univ. of Warwick
(CRM-ISM)

***Masakova, Suzana***
Czech Technical Univ.
(NATO)

***Mei, Ming***
Kanazawa Univ.
(CRM-McGill)

***Pal, Ambrus***
Colombia Univ.
(CRM-ISM)

***Penskoi, Alexei***
Univ. de Montréal
(CRM)

***Prasad, Amritanshu***
Univ. of Chicago
(CRM-McGill-CICMA)

***Rasmussen, Jorgen***
Univ. of Lethbridge
(CRM-ISM)

***Saikia, Anupam***
Trinity College, Univ. of Cambridge
(CRM-ISM)

***Sikora, S. Adam***
Univ. de Maryland
(CRM-ISM)

***Tempesta, Piergiulio***
Univ. degli studi di Lecce
(CRM-ISM)

***Urquiza, José***
Univ. Pierre et Marie Curie
(nc$m_2$)

***Vénéreau, Stéphane***
Institut Fourier
(CRM-McGill-ISM)

***Vitse, Pascale***
Univ. de Bordeaux I
(CRM-ISM)

***Wang, Sung Ho***
Duke Univ.
(CRM-ISM)

**Next is a separate list for the postdoctoral fellows specifically involved with MITACS projects attached to the CRM. The affiliation listed indicates where the research is being done.**

***Bao, Weisheng***
Montréal Heart Institute

***Chavez, Francisco***
Univ. of Toronto

***Deerakhchan, Katayoun***
Montréal Heart Institute

***Farhat, Abdeljelil***
CIRANO

***Hong, Gu***
Univ. of Waterloo

***Hadjar, Ahmed***
Polytechnique

***Kagabo, Issa***
Polytechnique

***Langdell, Stephen***
Univ. de Montréal

***Mladenovic, Nenad***
HEC

***Nagai, Yoshihiko***
Univ. McGill

***Nagih, Anass***
HEC

***Rousseau, Guillaume***
Univ. of Toronto

***Schaefer, Carsten***
Univ. McGill

***Shinagawa, Kaori***
Montréal Heart Institute

***Stojkovic, Goran***
Polytechnique

***Sun, Hui***
Montréal Heart Institute

***Tateno, Katsumi***
Univ. McGill

***Villeneuve, Daniel***
Polytechnique

***Ziarati, Koorush***
HEC

**MITACS Postdoctoral fellows 2001-2002:**

***Bao, Weisheng***
Montréal Heart Institute

***Bub, Gil***
McGill Univ.

***Caporossi, Gilles***
Univ. de Montréal

***Chavez, Francisco***
Univ. of Toronto

***Deerakhchan, Katayoun***
Montréal Heart Institute

***Hadjar, Ahmed***
Polytechnique

***Hong, Gu***
Waterloo Univ.

***Ichiro, Takeuchi***
Univ. de Montréal

***Kagabo, Issa***
Polytechnique

***Nagai, Yoshihilo***
McGill Univ.

***Nagih, Anass***
HEC

***Shinagawa, Kaori***
Montréal Heart Institute

***Slimane, Leila***
Univ. Laval

***Stojkovic, Goran***
Polytechnique

***Stojkovic, Mirela***
Polytechnique

***Takafumi, Kanamori***
Univ. de Montréal

***Tateno, Katsumi***
McGill Univ.

***Villeneuve, Daniel***
Polytechnique

***Wang, Xiangdong***
Univ. de Montréal

***Ziarati, Koorush***
HEC

***Zou, Renqiang***
Montréal Heart Institute

# Visitors

**Each year the CRM receives a large number of visitors. The majority are here to participate in scientific activities: in the year 2000-2001, 1797 such participants registered for workshops run solely by the CRM. In addition, the CRM helped fund about 21 other scientific events. The following list does not include those short-term visitors, only those who visited for longer periods, ranging from over a week to several months.**

***Abreu, Miguel***
The Fields Institute

***Arnéodo, Alain***
C.N.R.S.

***Artes, Joan C.***
Univ. autonoma de Barcelona

***Asanuma, Terao***
Toyama Univ.

***Aschenbrenner, Matthias***
Univ. of Illinois

***Atoyan, Armen M.***
Moscow Eng. Physics Institute

***Auroux, Denis***
École Polytechnique (Palaiseau)

***Bandrauk, André***
Univ. de Sherbrooke

***Ben-El-Mechaiekh, H.***
Brock Univ.

***Benali, Habib***
CHU, Pitié-Salpitrière

***Berest, Yuri***
Cornell Univ.

***Bertolini, Massimo***
Univ. di Pavia

***Biran, Paul***
Tel Aviv Univ.

***Bolibroukh, Andrej***
Univ. de Strasbourg

***Branner, Bodil***
Technical Univ. (Denmark)

***Bryant, David***
McGill Univ.

***Buium, Alexandru***
Univ. of New Mexico

***Bullough, Robin***
Univ. of Manchester

***Burnod, Yves***
CHU Pitié-Salpêtrière

***Calin, Iurie***
Academy of Sciences of Moldova

***Campbell, Sue Ann***
Univ. of Waterloo

***Cao, Xifang***
Yangzhou Univ.

***Chadam, John***
Univ. of Pittsburg

***Chavarriga, Javier***
Univ. de Lleida

***Chekanov, Yuri***
ETH Zurich

***Chen, Huaihui***
Nanjing Normal Univ.

***Cojocaru, Alina Carmen***
Queen's Univ.

***Cozma, Dumitru V.***
Tiraspol State Univ.

***Cummins, Chris***
Univ. Concordia

***D'Acunto, Didier***
Univ. de Savoie

***Dancer, Andrew***
Oxford Univ.

***Dechevsky, Lubomir***
Sofia Technical Univ.

***Douady, Adrien***
Univ. de Paris

***Dubeau, François***
Univ. de Sherbrooke

***Dumortier, Freddy***
Limburgs Univ. Centrum, Belgique

***Eynard, Bertrand***
CEA Saclay

***Françoise, Jean-Pierre***
Univ. Paris VI

***Frappat, Luc***
CNRS, LAPP

***Frougny, Christiane***
LIAFA (Paris)

***Garnero, Line***
CHU Pitié-Salpêtrière

***Golding, Brian G.***
McMaster Univ.

***Grau, Maria Teresa***
Univ. de Lleida

***Grotschel, Martin***
Univ. Berlin

***Guruswamy, Sathya***
Institute for Theoretical Physics (Amsterdam)

***Hadj-Amar, Hassiba***
Institut aéronautique de Saint-Cyr

***Herz, Andreas***
Humboldt-Univ. Berlin

***Ilyashenko, Yulij***
Steklov Institute

***Jackiw, Roman W.***
MIT

***Jun, Li***
Univ. de Montréal

***Kaloshin, Vadim***
Princeton Univ.

***Kihel, Karim***

***Laforge, Christophe***
Laboratoire de physique du solide (Bruxelles)

***Lamb, Jeroen***
Imperial College

***Le Bris, Claude***
Ecole Nationale des ponts et chaussées

***Llibre, Jaume***
Univ. Autonoma de Barcelona

***Longtin, André***
Univ. d'Ottawa

***Ludwig, Andreas***
Univ. of California, Santa Barbara

***Mardesic, Pavao***
Univ. de Bourgogne

***McLarity, Colin***
Case Western Reserve Univ.

***Miasnikov, Alexei***
City College of CUNY

***Michaux, Christian***
Univ. de Mons-Hainaut

***Miller, Christopher***
Ohio State Univ.

***Monastyrsky, Michael***
ITEP

***Moosa, Rahim***
Univ. of Illinois at Urbana-Champaign

***Mourtada, Albelraouf***
Univ. de Bourgogne

***Murty, Ram***
Queen's Univ.

***Novikov, Dmitry***
Univ. of Toronto

***Ono, Kaoru***
Hokkaida Univ.

***Ouansafi, Abdellatif***
Univ. Mohammed V

***Patera, Jan***
Czech Technical Univ.

***Pelantova, Edita***
Faculty of Nuclear Sc. and Physics Eng. (Czec Republic)

***Pereira, Jorge***
Instituto de Matematica Pura e Aplicada, Rio (Brazil)

***Pidstrigach, Victor***
Georg-August-Univ. Goettingen

***Pierre, Roger***
Univ. Laval

***Polis, Michael P.***
Oakland Univ.

***Polterovich, Leonid***
Tel Aviv Univ.

***Pong, Wai Yan***
Univ. of Illinois at Urbana Champaign

***Raffinot, Mathieu***
Univ. de Versailles

***Rolin, Jean-Philippe***
Univ. de Bourgogne

***Semerdjiev, Emil A.***
Bulgarian Academy of Science

***Sikorav, Jean-Claude***
École Normale Supérieure de Lyon

***Speissegger, Patrick***
Univ. of Wisconsin

***Spiridonov, Vyacheslav***
Laboratory of Theoretical Physics (Dubna)

***Stievenart, Nathalie***
Univ. Concordia

***Suba, Alexandru***
State Univ. of Moldova

***Svobodova, Milena***
Faculty of Nuclear Science and Physics Engineering

***Thiriet, Marc***
INRIA

***Tompaidis, Stathis***
Univ. of Texas at Austin

***Tremblay, André-Marie***
Univ. de Sherbrooke

***Tsvelik, Alexei***
Univ. of Oxford

***Unser, Michael***
Swiss Federal Institute of Technology Lausanne

***Van den Dries, Lou***
Univ. of Illinois

***Vulpe, Nicolae***
Academy of sciences of Moldova

***Waterman, Michael***
Univ. of Southern California

***Wiegmann, Paul***
Univ. of Chicago

***Winfree, Arthur T.***
Univ. of Arizona

***Yakovenko, Sergey***
The Weizmann Institute of Science

***Young, Carmen***
Fields Institute

***Zell, Thierry***
Purdue Univ.

***Zeron, Eduardo Santillan***
Univ. Konstanz

***Zhedanov, Alexei***
Donetsk Univ.

***Zhu, Huaiping***
Univ. of Waterloo

# 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.**

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

***Bergeron, François***
UQAM

***Brassard, Gilles***
Univ. de Montréal

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

***Cléroux, Robert***
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***Hubert, Joseph***
Assoc. Dean,
Research, FAS
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***Hurtubise, Jacques***
Director CRM,
Univ. McGill

***Hussin, Véronique***
Univ. de Montréal

***Kowaliczko, Béatrice***
Secretary

***Léger, Christian***
Dep. Dir. CRM,
Univ. de Montréal

***Lessard, Sabin***
Univ. de Montréal

***LeTourneux, Jean***
Univ. de Montréal

***Rémillard, Bruno***
UQRT

***Rousseau, Christiane***
Univ. de Montréal

## 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 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. The directors and the deputy directors are members of the committee; the outside members comprise:**

***Borwein, Jonathan***
President, CMS
Simon Fraser Univ.

***Glynn, Peter***
Stanford Univ.

***Hambleton, Ian***
McMaster Univ.

***Hitchin, Nigel***
Oxford Univ.

***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.

# Computer Facilities

The CRM offers to 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 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.

The software libraries include compilers (FORTE environment for C, C++ and Fortran, GNU compilers, Java, etc.), symbolic manipulation programs (Mathematica, Maple, Macaulay), several text editors, web browsers, mail tools, and most utilities common to the mathematical world (fftw-Discrete Fourier Transform, dstool-tool for dynamical systems, etc.). Upgrades to TeX and its dialects are uploaded whenever they are released. Unix softwares to interwork with PC and Mac world are also installed, such as SAMBA (PC file and printer server), StarOffice (Office suite), and AUFS (file server for Macintosh). In 2001, the Web server (Apache under Unix) was updated with secured tool SSL and a recognized 128-bit Thawte certificate that enables secured registration for participants to CRM activities. Also a new look to the contents of our web pages is actually in progress since the summer of 2001.

Security awareness has triggered new measures and updates (for instance, the installation of surveillance softwares), with more to come in the future. In particular, all the CRM's computers acquired within the last 2 years have been connected to a new alarm system.

Since 1999, the CRM operates its own private local area network (LAN): five BayNetworks Baystack-450 switches, providing 120 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 the Université de Montréal that maintains the connections with RISQ (Réseau interordinateurs scientifique québécois) and CA*net (the Canadian internet transit service). Members and guests are now able to connect their personal laptops (or computers) on the CRM private network directly, or, from outside the CRM offices, through phone links to our PPP server and its 4 modems.

The support staff works on Sun stations, X-terminals or on Macintoshes tied to the Sun server for all services, such as mail and backups. A 3-years plan for replacement of all support staff computers started in 1999 will be completed in 2002. In Spring 2001, a project to implement the phase 1 of a new database was initiated. This database will help support staff to better manage the contacts, activities, registrations to activities, and offices of CRM. Phase 1 should be completed by end of summer 2001, and a phase 2 is already planned for 2002.

For printing, the CRM has two HP-8000DN workgroup printer (1200-dpi double-sided), a jet-ink network printer Epson-900N for color printing, and some small printers for support staff.

The CRM has its servers installed in a room specifically designed for computers, with independent controlled environment and UPS (Uninterruptible Power Supply).

The main server (Enterprise-450), 22 Sun workstations Ultra-5 and Ultra-10 and the complete Local Area Network installed in 1999 were all paid by a grant from the Canadian Foundation for Innovation together with the Government of the Province of Quebec and a donation (20% of total value) from Sun Microsystems (for computers) and Anixter (for the network).

# 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), Mathematical Physics (1999-00). A year's activities can combine a good number of workshops and conferences, one or two Aisenstadt chairs, a 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 2000-2001: Mathematical Methods in Biology and Medicine

### Overview

The year 2000-2001 at the CRM was 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 emphasized both aspects, with workshops covering various applications of non-linear dynamics in biology and medicine, as well as genomics, and medical imaging.

The year has been a great success with more than 1503 participants to the various activities of the thematic year, including more than 700 graduate students and postdoctoral fellows.

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

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

Instructors : E. Doedel (Concordia), R. Edwards (Victoria), L. Glass (McGill), M. Guevara (McGill), A. Longtin (Ottawa), M. C. Mackey (McGill), J. Milton (Chicago), M. Titcombe (UQAM), A. Vinet (Montréal), J. Bélair (Montréal).

Reprenant la formule à succès de l'École du même titre (tenue en 1996, puis répétée en 1997) au Centre de dynamique non linéaire en physiologie et en médecine de McGill (CNLD), cette École offrait une solide introduction aux outils de modélisation de régulation biologique approchée par la théorie des systèmes dynamiques. Un accent particulier a été mis sur les applications médicales, par une intégration étroite de la théorie et des résultats expérimentaux, tant de la littérature clinique que de simulations numériques. Elle a attiré 55 participants dont 37 étudiants aux études supérieures et boursiers postdoctoraux.

Deux traits distinctifs de cette École sont dignes de mention. D'abord, la très étroite coordination entre les différents enseignants, tous choisis pour leurs connaissances acquises d'expérience dans l'application pratique de la dynamique non linéaire aux systèmes biologiques. Souvent, dans de telles Écoles, les conférenciers connaissent seulement un des deux aspects du domaine. Ensuite, un laboratoire informatique quotidien planifié pour illustrer les concepts des leçons par l'entremise d'expériences numériques utilisant un logiciel écrit par les conférenciers. Des étudiants des deuxième et troisième cycle du CNLD, de même que les conférenciers ont fait office d'assistants de laboratoire afin de servir de compléments aux instructions du manuel de laboratoire.

Une évaluation systématique a été recueillie auprès des étudiants, et a démontré un taux uniforme de très grande satisfaction, invitant à reprendre la formule dans le futur.

### 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).

Combinatorial Pattern Matching (CPM) addresses issues of searching and matching strings and more complicated patterns such as

trees, regular expressions graphs, point sets, and arrays. The goal is to derive non-trivial combinatorial properties of such structures and to exploit these properties in order to achieve superior performance for the corresponding computational problems. Over recent years a steady flow of high-quality research on this subject has changed a sparse set of isolated results into a fully-fledged area of algorithmics. This area is continuing to grow even further due to the increasing demand for speed and efficiency that comes from important and rapidly expanding applications such as the World Wide Web, computational biology, and multimedia systems, involving requirements for information retrieval, data compression, and pattern recognition. The objective of this annual CPM gathering was to provide to its 73 participants an international forum for research in combinatorial pattern matching and related applications.

## 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. RECOMB 2001 was a great success, with over 600 participants. It was held at the Wyndham Hotel, in downtown Montreal, with a banquet in the piano nobile of Place des Arts.

The Distinguished Biology Lecture was given by Phillip Sharp (*RNA Biology and the Genome);* the Stanislav Ulam Memorial Computational Biology Address by George M. Church, *(Hunger for new technologies, metrics, and spatio-temporal models in functional genomics)* and the Distinguished New Technologies Lecture by Mark Adams (*The Sequence of the Human Genome).* Further keynote addresses were delivered by Yvonne Martin, *The Role of Computational Chemistry in Translating Genomic Information into Bioactive Small Molecules*, Roger Brent, *Information processing by cells and biologists*, Klaus Lindpaintner, *Genetics and Genomics: Impact on Drug Discovery and Development*, Mark Ptashne, *Imposing Specificity by Regulated Localization, Matthias* Wilm, *Creating the Backbone for the Virtual Cell: Cell Mapping Projects on the Run.*

There were special sessions on Protein Structure (Chair: *Isidore Rigoutsos*), Molecular Interactions (Chair: *Satoru Miyano*), Expression Patterns (Chair: *Ron Shamir*), Sequencing by Hybridization (Chair: *Michal Linial*), Sequence Analysis I (Chair: *Pavel Pevzner*), Phylogeny and Gene Duplications (Chair: *Tandy* Warnow), Sequence Analysis II (Chair: *Michael Waterman*), Sequencing (Chair: *Martin Vingron*), Proteomics, RNA Structure (Chair: *François Major*).

In addition the conference attracted 130 posters. There were 13 commercial booths, as well as software demonstrations by Entigen, InPharmix, and Biobase.

Support was received from the US Department of Energy, the US National Science Foundation, Celera Genomics, Lion Bioscience, Compaq, the Ministère de l'Industrie et du Commerce (Québec), SmithKline Beecham, Aventis Pharma, the Centre de recherche en calcul appliqué (CERCA), the International Society for Computational Biology and the Université de Montréal.

## 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),

Cet atelier visait une discussion sur l'algorithmique derrière les systèmes informatiques les plus nouveaux et les plus sophistiqués en science de l'ARN. Les 46 participants ont bénéficié des présentations par les conférenciers invités : C. Duarte *From 20 atoms to 2 : descriptors of RNA conformation*; E.Rivas *Computational paradigms for RNA structure analysis and prediction : a multifaceted approach*; M.Venkantraman *RNA structure based drug design*; C.Wilson *Informatic approaches to RNA secondary and tertiary structure prediction*. Les étudiants ont également eu l'opportunité de présenter leurs travaux de recherche lors d'une session spéciale et sous forme d'affiches.

## Workshop on Bioinformatics

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

Tenu dans le cadre du 68e congrès de l'Association canadienne-française pour l'avancement des sciences, ce colloque d'une durée d'un jour a abordé des aspects variés, mais complémentaires, de la bioinformatique. Le but du colloque a été de faire le point sur les différentes expertises présentes au Canada et d'aborder les nouvelles problématiques de la bioinformatique.

La journée s'est déroulée sur deux sessions. Celle du matin a porté sur *l'analyse structurale et fonctionnelle du génome*. Ce domaine a pour objectif d'exploiter la masse d'information génétique disponible afin de découvrir les éléments qui jouent un rôle prépondérant dans l'expression des gènes, la fonction et la stabilité des protéines et les interactions protéiques.

La première présentation a été celle de Pierre Rouzé (Gent) qui nous a présenté, de façon très pédagogique, les différentes questions qui se sont posées lors du séquençage et de l'annotation du génome de la plante *Arabidopsis Thaliana*, et comment ces données sont utilisées pour déduire des informations sur l'expression des gènes. Donald Forsdyke (Queen's) a ensuite présenté différents aspects liés à la composition en bases de l'ADN. Cette présentation a suscité une discussion très intéressante. L'un des projets majeurs des chercheurs canadiens consiste à exploiter les données structurales et fonctionnelles du génome dans le but de comprendre, modéliser et prédire les conséquences des pathways métaboliques. Anthony Kusalik (Saskatoon) et Gregory Butler (Concordia) nous ont présenté des aspects importants de ces études. Isabelle Barrette (Montréal) et Guylaine Poisson (Montréal) ont, quant à elles, présenté une étude concernant des motifs conservés impliqués dans les maladies du prion. Cette présentation a suscité l'intérêt de la journaliste présente.

La deuxième session, qui a eu lieu l'après-midi, portait sur la *Génomique comparative et la phylogénie*. La méthode traditionnelle pour déduire des relations d'évolution entre les espèces consiste à comparer les séquences d'un même gène dans différents génomes. Cependant, des gènes différents fournissent des informations différentes. Une méthode alternative consiste à comparer l'ordre des gènes dans les génomes en considérant des mutations globales (opérations de réarrangement de blocs de gènes.) Étant donné qu'une multitude de génomes sont maintenant complètement séquencés, en particulier des génomes de bactéries, il devient possible d'inférer des relations d'évolution à partir de la totalité du matériel génétique des espèces. Les études d'évolution ne sont pas seulement intéressantes d'un point de vue théorique. Elles servent également à orienter la comparaison de séquence d'une manière à faciliter la prédiction des structures d'ARN et de protéines, et par conséquent, la fonction de ces protéines.

Les conférenciers invités, N. El-Mabrouk (Montréal), A. Nip (Montréal) et D. Sankoff (Montréal), ont abordé des aspects différents liés à la construction d'arbres de phylogénie, au calcul de distances d'évolution basées sur l'ordre des gènes et à la construction de cartes génétiques facilitant la comparaison génomique.

Le succès de ce colloque ne fait aucun doute puisque plus de 30 personnes y ont assisté, ce qui dépasse toutes les estimations initiales. Les participants étaient des étudiants des différentes universités francophones et anglophones de Montréal, quelques étudiants de l'Université de Sherbrooke et également des personnes travaillant dans des entreprises privées liées de près ou de loin à la bioinformatique. Cette diversité d'audience a suscité des questions et des discussions très intéressantes tout au long de la journée.

## Workshop on Molecular, Metabolic, and Gene Control Networks

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

The living cell is a marvellous chemical machine, carrying out thousands of chemical and physical transformations that permit its own survival and reproduction. Every chemical and physical process within the cell must be exquisitely regulated at the molecular level to meet the demands of life. A fundamental goal of modern cell biology is to uncover these molecular control circuits and to understand how they orchestrate the observed physiological properties of the living cell.

These problems are crying out for mathematical analysis and simulation. The *Millennium Reviews* issue of *Cell* (January 7, 2000) highlighted a pressing need for theoretical and computational tools to make sense of the dynamical interactions among proteins in these fundamental regulatory

networks. For instance, Brent (*Genomic Biology*, pp 169-183), after reviewing modern developments in genomics and proteomics, points out that "For a few prokaryotes and subsystems within eukaryotic cells, we are at or near a level of description where we can enumerate key players… Better predictive ability may depend on representations [of the key players] that incorporate kinetic information. The classical frameworks for this are, of course, systems of differential equations that describe the rates at which enumerated species change."

This workshop focused on the molecular regulatory systems that control cell metabolism, gene expression, environmental responses, development, and reproduction. As in man made machines, these regulatory networks can be described by non-linear dynamical equations, for example, ordinary differential equations, reaction-diffusion equations, stochastic differential equations, or cellular automata. The invited talks illustrated a range of theoretical problems presented by modern concepts of cellular regulation, some strategies for converting molecular mechanisms into dynamical systems, some useful mathematical tools for analyzing and simulating these systems, and the sort of results that derive from serious interplay between theory and experiment.

The workshop was attended by 41 individuals from Canada, the United States, Mexico and five European countries. They ranged from senior university faculty (20) through postdoctoral fellows (5), graduate students (12) and medical students (1) to undergraduates (3). According to the attendees, the workshop was highly successful. The organizer continues to receive positive comments, as well as requests for a repeat venue. Another sign of its success is that the Editorial Board of the American Institute of Physics journal *Chaos* invited John Tyson and Michael Mackey to co-edit a Focus Issue of that journal for the first number of volume 11 (March, 2001).

The format of three talks in the morning and two talks in the afternoon afforded participants the opportunity to interact informally. There were also other occasions to meet in an informal and relaxed atmosphere, which were one of the prime contributors to the success of the workshop. There were 19 invited talks spanning the four days: Dennis Bray, *Stochastic Models of Cell Signalling*; George Church, *New Technologies and Models in Time-series RNA Array Data*; John Ross, *New Approaches to Determining Mechanisms of Complex Reactions*; Joe Mahaffy, *DNA Replication and Cell Growth for E. coli*; Leon Glass, *Can Simple Equations be Used to Model Real Gene Networks?*; James Ferrell, *Biochemical Hysteresis and the Irreversibility of the Differentiated State*; John Tyson, *Control of the Eukaryotic Cell Cycle: Molecules, Mechanisms, and Mathematical Models*; Paul Smolen, *Modeling Circadian Oscillations with Interlocking Positive and Negative Feedback Loops*; Kurt Kohn, *Molecular Interaction Maps as Information Organizers and Simulation Guides*; Marc Roussel, *Invariant Manifold Methods for Metabolic Model Reduction*; Moises Santillan, *Mathematical Models of the Tryptophan Operon: Modeling Development and Stability Analysis*; Denis Thieffry, *Qualitative Analysis of Gene Networks*; Hanspeter Herzel, *Extracting Information from cDNA Arrays*; James Collins, *The Design and Construction of a Genetic Toggle Switch*; Raima Larter, *Calcium Waves and Other Nonlinear Dynamic Behaviors in the Brain*; Albert Goldbeter, *Modeling the Molecular Bases of Ultradian and Circadian Rhythms*; Roland Somogyi, *Challenges in Data Mining and Computational Modeling for the Interpretation of Molecular Networks*; Johan Paulsson, *Copy Number Control in Plasmid Replication*.

## 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. Andersson (Uppsala University), Jeffrey Boore (University of Michigan), P.Bork (EMBL Germany), G.Brown (Univ.Victoria), D.Bryant (McGill), A.Caprara (Univ.Padova), O.Cohen (Univ. Joseph Fourier), J.Cotton (Univ. of Glasgow), J.Demongeot (Université Joseph Fourier de Grenoble), K.M. Devos (Norwich Research Park), J.Dicks (Norwich Research Park), E.Eichler (Case Western Reserve University), N.El-Mabrouk (Univ.Montréal), K.Eriksson (Malardalen Univ.), C.Gallut (Université Pierre et Marie Curie), D.Goldberg (Cornell University), A.L. Hughes (University of South Carolina), R.K. Jansen (University of Texas), J.Kleinberg (Cambridge University), G.Lancia (University of Padova), D.Liben-Nowell (Massachusetts Institute of Technology), L.A. Lyons (University of California Davis), B.F. McAllister (University of Texas at Arlington), A.McLysaght (University of Dublin), J.Meidanis (Universidade Estadual de Campinas), A.Nip (Université de Montréal), I.Parkin (Agriculture and Agri-Food Canada), A.H. Paterson (University of Georgia), I.Pe'er (Tel Aviv University), P.A.Pevzner (University of Southern California), D.Sankoff (Université de Montréal), D.J.Schoen (McGill University), R.Shamir (Tel Aviv University), J.Tiuryn

(Warsaw University), Z.Trachtulec (Academy of Sciences of the Czech Republic), T.J. Vision (Cornell University), D. Waddington (Roslin Institute, Edinburgh), J.E. Womack (Texas A&M University).

This meeting brought together 68 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), Philippe Tracqui (Grenoble)**

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).

Ce colloque s'est tenu dans le cadre et sous le format des Treizièmes Entretiens Jacques-Cartier. Tous les participants ont beaucoup apprécié le colloque et noté la très grande qualité des exposés. Une particularité de ce colloque est que la plupart des exposés ont été donnés en français et beaucoup de participants ont apprécié cette chance unique qui leur avait été donnée de faire de la science en français.

Les cinq organisateurs du colloque : Pierre Auger (Lyon 1), Président de la Société Française de biologie théorique, Jacques Demongeot (Grenoble), Président de la Société européenne de biologie théorique et de biomathématique, Philippe Tracqui (Grenoble), Jacques Bélair (CRM et SCMAI), Christiane Rousseau (CRM et SMC) se sont rencontrés pour explorer les possibilités de collaboration future entre les biomathématiciens et les sociétés scientifiques les représentant. Du côté canadien le réseau canadien de centres d'excellence MITACS vise à développer les retombées industrielles des mathématiques dans les systèmes complexes, et le secteur biomédical y occupe une place de choix. Ce réseau suit la création du réseau de calcul et de modélisation mathématique, $rcm_2$, un consortium québécois de centre de recherches en sciences mathématiques visant à offrir une vitrine unifiée aux industriels appelés à employer et développer des technologies hautement mathématisées. D'autre part, en France, l'acquisition conduite par la modélisation y est perçue comme une voie privilégiée permettant de réunir les communautés du traitement de signal et d'image et de modélisation sur des recherches communes.

## Workshop on Memory, Delays and Multistability in Neural Systems

**October 11-15, 2000**
**Org.: André Longtin, (Ottawa )**

The purpose of this high-level workshop was to bring together scientists working on three aspects of neural function: 1) memory, especially short-term as opposed to long term; 2) delays in neural activity propagation, and 3) multistability, i.e. the coexistence of two or more attractors for the dynamics of a system of neurons. All invited speakers were neural modelers with various levels of mathematical expertise active in one or more of these areas. Memory and multistability go together, since a system with memory must evolve to one of many coexisting states. However, multistability has also been found in a variety of recent studies without being associated with memory. Delays enter the picture because they can make systems multistable, and have been implicated in recent studies of memory in real and artificial neural networks.

The achievements of the workshop was to 1) raise the awareness of the commonalities of those areas, 2) enable new insights into solving the mathematically challenging problems of delays and multistability in nonlinear dynamical systems, 3) ignite new collaborations between the participants, and 4) spur the interaction of theory with neurobiological experiment. This latter interaction was possible because almost all speakers worked on real neural systems. Key figures in nonlinear delay-differential equations also extended the workshop into the realm of pure mathematics.

The open workshop attracted 50 participants. Its format consisted of twenty-two 40-minute invited talks and sixteen 20-minute contributed talks, and a handful of poster presentations. Each invited (contributing) speaker was encouraged to finish after 30 (15) minutes to allow plenty of discussion time, an important aspect of the workshop. There had been no

previous workshop of this timely subject, one of the reasons for its success. The other reason was the excellence and accessibility of the talks, and the willingness of this diverse group to exchange in a friendly atmosphere.

The workshop began with Dynamical Memory. G. Carpenter gave an overview of adaptive resonance theory for real-time neural networks, emphasizing how synaptic strength can be redistributed to enhance stable pattern learning. S. Becker modeled hippocampal-parietal interactions in spatial memory, exploring how they allow translation between allocentric and egocentric spatial representations. Next came more general perspectives on Neural Computing. W. Maass put forth a "wetware" theory better suited to neurons that the Turing machine; it analyzes computations based on transient events. Since responses to stimuli (such as visual perceptions) exhibit multistability with analog properties, unlike pure digital multistability, Richard Hahnloser (MIT) proposed a neuromime circuit with digital-like multistability and analog amplification. In the third session was on Delayed Dynamics, S.A. Campbell and J. Belair gave an excellent joint tutorial on bifurcation theory and multistability applied to delay equations modeling neural circuits. J. Wu analyzed how various patterns such as equilibria, phase locked orbits, and standing waves arose in simple networks with delayed feedback. And U. Ernst showed how multistability can lead to phase clustering in subsets of cells in a neural network, with the interesting result that the number of such subsets decreases with increasing delay.

In the session on Recurrent Dynamics and Phase Resetting, Leon Glass presented results from studies on both cardiac and neural systems where stimuli given at fixed delay can yield complex bursting rhythms. C. Canavier presented an analysis of loop circuits of oscillators in which delayed feedback gives rise to multistability. J. Milton presented experimental work supported by theory on delayed recurrent neural loops that include a computer. This led to fascinating speculations on the neural code based on multistability and statistical periodicity. K. Pakdaman gave a different twist to delayed dynamics by analyzing the transient properties of such circuits. The sessions on Bursting Dynamics and Neural Information Processing continued a progression down to single cell dynamics, before moving back up to more macroscopic network dynamics. E. Izhikevich proposed an impressive classification of bursting cells into 120 categories, based on bifurcation theory. S.K. Han demonstrated the stunning (and humbling!) complexity of the bifurcation structure of a simple "bursting" circuit of two coupled neuronal oscillators. K. Aihara presented the computational and coding advantages of chaotic spatio-temporal firing patterns. A. Herz reviewed how neural nets can store temporal patterns, and proposed that temporal relations could be stored and later used for nontrivial computations. A. Destexhe presented results on real neocortical cells that suggest how they can perform finer detection when their state is highly noisy. And W. Gerstner developed an integral equation formulation of his "spike response method" to analyze the effect of delays and noise on signal transmission.

M. Ding led the session on higher level Sensorimotor Dynamics with an analysis of long term correlations in timing errors that arise (likely) from neural processes acting on multiple time scales. R. Engbert presented a study of the delayed coordination of eye saccades and attention shifts during reading. Finally the workshop wrapped up with the "highest level" functions. C. Laing presented a model for binocular rivalry, a form of multistable perception that occurs e.g. with the Necker cube. And H. Wilson tied a single cell property (adaptation) to high-level multistable effects such as perceptual oscillations (illusions, binocular rivalry) and bursting during migraine auras.

## Workshop on Mapping and Control of Complex Arrhythmia

**October 29– November 1, 2000**
**Co-sponsor: Guidant Inc.**
**Org. : Leon Glass (McGill)**

This workshop brought together a diverse group of undergraduate and graduate students, postdoctoral fellows, physicians, and industrial representatives to discuss the control of complex arrhythmias. There were attendees from Canada, the United States, France, Switzerland, Germany, Belgium, and Mexico. The conference was partially funded by a grant from medical equipment manufacturer Guidant Inc. The conference was also closely related to the MITACS project of Leon Glass and several

individuals participating in that project attended and spoke at the meeting.

The level of the presentations was uniformly high, and there was a relaxed atmosphere and schedule that allowed lots of time for discussion. Although this was particularly beneficial for students, several of the senior scientists mentioned that unlike usual conferences, this workshop had enough time for serious discussion. In addition, the presence of several experimentalists and physicians provided connection with current medical and experimental advances. The presentations of A. Shrier (McGill), K. Stein (New York Presbyterian Hospital), S. Nattel (Montreal Heart Institute) in particular generated lots of discussions about experimental methods and potential connections between experimental and clinical work and theory. Powerful computational approaches were emphasized in presentations by M. Guevara (McGill), J. Leon (Calgary), Y. Rudy (Case Western), A. Vinet (Montreal), F. Fenton (Northeastern), N. Virag (Medtronic Europe), C. Zemlin (Berlin), N. Trayanova (Tulane), G. Rousseau (Paris 7). The connections between experimental observations and theory were an important element of many of these presentations. In some cases, physicists and mathematicians have been successful in initiating experimental and clinical studies in collaboration with clinical and experimental colleagues and this was a primary focus of presentations by A. Garfinkel (UCLA), D. Christini (Cornell University Medical College), R. Ideker (Alabama), D. Gauthier (Duke), H. Hastings (Hofstra). Beautiful analytic work on complex dynamics was presented by A. Karma (Northeastern) and V. Hakim (Paris). V. Krinsky (Nice) presented ideas about a new medical device to detect the source of serious arrhythmias. Finally, though the focus of the conference was on cardiac arrhythmias, there were also two presentations concerning control of neurological arrhythmias by J. Collins (Boston) and A. Beuter (UQAM). Overall, there was an excellent balance of topics on a common theme and a critical mass of superb scientists. Indeed, there were 54 participants, including 18 graduate students and 4 postdoctoral fellows.

Although there will be no conference proceedings as such, several of the conference participants will be invited to contribute to a Focus issue on Complex Arrhythmia in the journal *Chaos*. This conference should therefore have a long-term impact on the future development of this field.

## 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), F. Nekka (Montréal), B. Sapoval (Polytechnique), C. Tricot (Clermont-Ferrand), M.J. Turner (De Montfort)

Les développements les plus récents de la géométrie fractale, tant du point de vue mathématique que du point de vue des applications, ont été présentés. Les conférenciers ont systématiquement insisté sur les obstacles entre la théorie et la pratique, mais aussi présenté des avenues fort prometteuses d'emploi des outils fractals dans l'analyse de nombreuses structures biologiques, incluant la génomique fonctionnelle. La lacunarité, en particulier, a été identifiée comme un concept digne d'un traitement mathématiquement plus approprié que celui disponible actuellement.

La conférence a attiré 35 personnes dont 11 étudiants aux études supérieures et 2 boursiers postdoctoraux. Les commentaires des participants, comme des conférenciers, ont été très positifs, quelques-uns de ces derniers manifestant par courriel leurs remerciements aux organisateurs.

## Workshop on Mathematical Methods in Brain Mapping

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

Invited speakers: R. Adler (TECHNION), 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.), N. Lange (Harvard Psychiatry & BioStats), 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 brought together 63

participants including mathematicians and statisticians interested in brain mapping, and medical researchers interested in mathematical and statistical methods for the analysis of brain mapping data. Talks were organized in four sessions: fMRI (Friston, Glover, Smith, Hartvig), fusion of fMRI and EEG (Dale, Brown, Riera, Ozaki, Valdes), structure (Mangin, Ashburner, Hurdal, Aston), cortical surface mapping (Poline, Kiebel, Chung, Polzehl, Taylor).

## Workshop on Population Genetics at the Molecular Level

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

The focus of this workshop was the recent developments that have occurred in population genetics as a result of the many new innovations that have occurred in the biological technologies devoted to analysing molecular variation. It is now possible to determine the differences that exist between individuals, between populations and between species in the finest molecular detail. We can now routinely determine the DNA nucleotide sequence over a length of thousands of base pairs from hundreds of individuals within a week's time. This has necessitated corresponding changes in the theory that is used to make biological sense of this information. The amount of data and its precision have provided far more biological information that was extracted by previous theories. The new theoretical developments have largely been attempts to extract this added level of information present within the data but much of it has also been in response to surprises that the new data has presented. As an example of just one of these surprises is the suggestion that bacterial genes are often not vertically transmitted. Most students are taught that an individual inherits their genes one copy from their mother and one copy from their father. Or in the case of bacteria, the single copy from their parent. But the sequence data that has been collected so far, and or analysis of it suggests that this is often not the case and that bacteria can simply pick up new genes from their environment and then incorporate these genes into their permanent genome. This unusual finding is forcing a re-interpretation of much of the evolution of bacteria.

There were eleven invited speakers. These individuals were chosen primarily as representatives of the young and exciting new theoreticians that will be shaping the structure of the population genetics theory over the coming decade. The invited speakers were Manolo Gouy (Bernard-Lyon), *Reconstruction of Distant Phylogenetic Relationships: Effect of more Realistic Models of Molecular Evolution*, Ziheng Yang (University College, London), *Estimation of Synonymous and Nonsynonymous Substitution Rates and Evolution of Mammalian and Drosophila Nuclear Genes*, Spencer Muse (North Carolina State), *Modeling Heterogeneity of Nucleotide Substitution Rates*, Rasmus Nielsen (Cornell), *Estimating Selection Coefficients from DNA Sequence Data using Codon based Likelihood Models*, Bruce Rannala (Alberta), *High-resolution Multipoint Linkage Disequilibrium Mapping in the Context of a Human Genome Sequence*, Andrey Rzhetsky (Columbia), *Computational Analysis of Regulatory Networks*, John Huelsenbeck (Rochester), *Likelihood-based Inference of Large Phylogenies*, Sudhir Kumar (Arizona State), *Estimating Neutral Substitution Rate in Mammals*, Jeff Thorne (North Carolina State), *Rate Evolution and Divergence Time Estimation*, Daniel Schoen (McGill), *Transposon Dynamics in Plants: Inferences from Phylogenetic Analyses and Site Occupancy Data*, and Brian Golding (McMaster), *Methods to aid in the Determination of Allelic Histories*.

The first talk demonstrated that unless very realistic models of evolution are used to infer phylogenetic histories then an incorrect inference might be made. This is very important for the revolutionary finding noted above - the suggestions of horizontal transfer are based on unusual phylogenetic histories - and on the organisms that we think the lineage leading to humans ultimately originated from. The next three talks each developed more accurate but also more complicated likelihood models that incorporated the effects of individual nucleotides in a non-independent manner (codon models incorporating selection) throughout the length of genes. The next two talks incorporated larger data sets that are being generated by genome projects to develop methods to map human genes and to map interaction pathways among proteins. The talks by Dr. Huelsenbeck and Dr. Thorne made use of likelihood Monte Carlo Markov models to reconstruct large phylogenies and to determine when rates of evolution might have changed within a phylogeny. The talk by Dr. Kumar was an attempt to use the massive amount of data from many mammalian species to estimate synonymous substitution rates. The talk by Dr. Schoen analyzed patterns of transmission of transposable elements in plants and lastly, Dr.

Golding presented some theory that permits calculation of the probabilities of individual allelic phylogenies.

The workshop attracted a comparatively large attendance. All told there were 62 registered participants including 34 graduate students and 7 postdoctoral fellows. There were participants from the United States, India, Germany, Brazil, and Canada.

## Workshop on Mathematical Formalisms for RNA Structure

**April 26 – 27, 2001**
**Org. : François Major (Montréal)**

Invited speakers: J. Brown (NCSU), J. Burke (Vermont), M. Carrillo (Stanford), D. Case (Scripps), Y. Ding (New York), S. Harvey (Alabama), P. Legault (Georgia), S. Lemieux (Montréal), N. Leontis (Bowling Green), J.-P. Perreault (Sherbrooke), P. Schuster (Vienna), P. Thibault (Montréal), A. Waugh (Stanford), E. Westhof (CNRS-Strasbourg).

Cet atelier visait une discussion sur l'état de l'art de l'informatique de l'ARN. Nous avions invité à notre avis les experts mondiaux dans la matière et nos objectifs furent atteints.
Les participants de l'industrie (US et Europe) et des sciences de l'ARN du Québec et des alentours furent pour la plupart impressionnés par le calibre des participants et des présentations. Somme toute, un excellent et de haut calibre atelier dans le domaine de l'ARN, probablement un des meilleurs dans le domaine depuis la conscientisation de l'importance de l'informatique en sciences de l'ARN. Le programme fut complété par une session d'affiches.

Les participants ont manifesté leur désir de voir cet évènement se répéter en 2002 et possiblement les années suivantes.

## 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 was a two-day tutorial on sequence analysis and other topics in computational biology and pattern matching that attracted 29 participants. The lectures titles were *BLAST ! How do you search sequence databases?* (G.Butler, C.Lam, G.Grahne); *Phylogeny* (D.Bryant); Algorithmic *aspects of speech recognition* (R.Giancarlo); *Genome rearrangement* (N.El-Mabrouk); *Flexible-pattern discovery* (L.Parida); *Adaptive test mining*: *inferring structure from sequences* (I.H.Witten).

### Developing the Tools: A Canadian Bioinformatics Workshop

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

The purpose of the workshop was to give the participants practical expertise and skills to parse and to manipulate the output of bioinformatics software; to modify and to extend existing bioinformatics software tools; to develop and to implement new bioinformatics data abstractions; to develop new bioinformatics applications using C++, Java; to build simple tools using the NCBI toolkit.

### Techniques in Brain Mapping

**December 5 - 8, 2000**
**Org. : Keith Worsley (McGill)**

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

In preparation for the workshop on brain mapping, three series of introductory lectures were given to 69 participants: R. Adler *Gaussian random fields: basics, maxima, Euler characteristics*; P.Valdes *EEG/MEG tomography: basics, statistical issues*; N.Lange *Brain mapping and anatomical magnetic resonance, functional and pharmacological imaging.*

### 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)

L'atelier *Ondelettes, fractales et imagerie médicale* a été organisé selon le format d'une série de conférences données au Centre de Recherches Mathématiques. La plupart des conférenciers, qui sont des experts reconnus au niveau international, ont été invités à exposer des mini-cours, suivi d'un séminaire portant sur les aspects les plus récents de leur recherche. Cette formule a été autant appréciée par les conférenciers que les participants.

Le premier conférencier, le Prof. M. Unser, est directeur du groupe d'imagerie biomédicale à l'École Polytechnique Fédérale de Lausanne (Suisse.) C'est un expert en imagerie et au traitement de l'information par les méthodes hiérarchiques et par les analyses en ondelettes et splines. En février 2001, le Prof. Unser a donné quatre conférences: *Splines: a perfect fit for*

*image processing*, *Pyramids and wavelets*, *Wavelets in biomedical imaging* et *Towards a unification: Wavelets, fractals, and radial basis functions*.

Les autres évènements se rattachant à cet atelier sont des conférences et tutoriaux présentés au cours de l'automne 2001. En octobre, le Prof. Noel Cressie (Dep. of Math. and Statistics, Ohio State Univ.) présente les modèles graphiques hiérarchiques et leurs applications en estimation de processus spatiaux (imagerie cérébrale); en novembre, le Prof. Rolf Riedi (Rice Univ., Texas) donne un exposé sur les processus multifractals; cet exposé est suivi par celui du Prof. Paul Scheunder, directeur du Vision Lab. Department of Physics à l'Universitée de Antwerp (Belgique), à propos de traitement de l'information dans les images médicales. Les autres conférenciers sollicités sont les Prof. Stella Atkins (Simon Fraser Univ.), Jacques Levy-Vehel (INRIA, Fr.) et Heinz-Otto Peitgen, directeur de CeVis & MeVis à l'Université de Bremen (Germany).

### Showcase for Competing Technologies for Phylogenetics (SCOPH)

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

Invited speakers: Olivier Gascuel (Montpellier, France), Tandy Warnow (Austin), David Bryant, Andreas Dress (Bielefeld, Germany), Kevin Nixon (Cornell), David Sankoff, David Swofford, John Hulsenbeck (Rochester), Mike Steel (Canterbury, NZ), Tom Hagedorn, and Joe Felsenstein (U. Washington)

Phylogenetics is the study of evolutionary history: the patterns of speciation and development that gave the diversity of life on earth. Phylogenetics is important not only for fundamental research; there are important applications in medicine, agriculture, conservation and ecology. The last decade or so has seen a remarkable growth in the field of evolutionary biology, due mainly to the interaction with molecular biology. Nucleotide, protein and, more recently, genomic data have proven to be invaluable sources of phylogenetic information.

Phylogenetics is now a thoroughly inter-disciplinary field, involving researchers from biology, ecology, bio-chemistry, computer science, mathematics and statistics. Inevitably, such diversity in backgrounds has led to difficulties in communication between researchers from different areas. The main goal of SCOPH was to begin to break down some of these barriers. We invited leading experts of phylogenetic technologies to present ninety-minute lectures covering both background material and recent developments. The speakers were encouraged to stimulate discussion and questions, and the attendees had the opportunity to have their phylogenetic questions answered by some of the top experts in the field. The approach proved popular: so popular in fact that we were forced to limit the number of registrants to the conference.

# 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, Frans Oort, Joel S. Feldman, Roman Jackiw, and Duong H. Phong.**

**The CRM was honoured to have as Aisenstadt chairholder, during the 2000-2001 theme year in Mathematical Methods in Biology and Medicine, Professors Michael S. Waterman of the University of Southern California and Arthur T. Winfree of the University of Arizona.**

***Professor Michael S. Waterman***
**University of Southern California**

**Michael S. Waterman** is Professor of Mathematics, of Biological Sciences, of Computer Science, and University Professor at the University of Southern California. He obtained a B.S. and an M.S. in Mathematics from Oregon State University before earning an M.A. and a Ph.D. in Statistics from Michigan State University. He started his academic career at the Idaho State University before spending more than five years at the Los Alamos National Laboratory, including two years as Project Leader. He took his current position in 1982.

Many awards have been bestowed on Professor Waterman, including being named Fellow of the American Association for the Advancement of Science, of the Institute of Mathematical Statistics, of the John Simon Guggenheim Foundation, and of the American Academy of Arts and Sciences. He is also one of only eight USC professors to hold the rank of University Professor and the first person to be appointed Celera Genomics Fellow.

He has served the community in various different ways, including as a member on Scientific Advisory Boards, session chair at an Oberwolfach meeting, member of the Programme Committee of the 9th Genome Informatics Workshop in Japan, and co-founder of the conference RECOMB, as well as member of its steering and programme committees. He has also served on many Editorial Boards, including as co-founder and Editor-in-chief of the *Journal of Computational Biology* and Associate Editor of the *Bulletin of Mathematical Biology*, and the *Annals of Combinatorics*. He has published more than 150 journal articles, one book, and edited or co-edited eight volumes.

His research concentrates on using computational approaches to study molecular sequence data. Currently the sequence databases double in size every two years, and new developments in sequencing technology could accelerate this rate of growth. The importance of computational methods to molecular biology is certainly growing proportionally. Part of his work has been to develop relevant and rigorous algorithms to compare and analyze nucleic acid and protein sequences. He was the first to introduce multiple gap weights to alignment algorithms and is co-developer of the Smith-Waterman algorithm. He is now studying the effects of different weighting schemes such as the Dayhoff matrix on the resulting optimal alignments. Also he has been studying the expected progress of physical mapping experiments which depends on the cloning vector, the fingerprinting scheme, etc.

Professor Waterman made two visits to the CRM. During his first visit, he gave three talks. *Reading DNA Molecules*, covered computational aspects of DNA sequencing which is at the intersection of molecular biology, biotechnology, and computing. In *Estimating Optical Maps*, he considered a fundamentally new experimental

approach to constructing restriction maps called Optimal Mapping, developed by Schwartz et al. (1993), which can rapidly produce ordered restriction maps of single DNA molecules by fluorescence microscopy. He discussed the use of a hierarchical Bayes model based on a mixture model with normal and random noise, a highly computer-intensive method for which an efficient algorithm is required. *The Probability of Matching Random Maps* considers the challenging problem of estimating the probability of observing a random match as good as obtained from the comparison of ordered restriction maps produced by gel electrophoresis or by optical mapping. In his second visit, Professor Waterman made two presentations. *Sequence Comparison and Database Searches* touched upon the dynamic programming approaches to sequence analysis for the comparison of a DNA or protein sequence with a database of known sequences. He also developed the statistical aspects of estimating statistical significance by Poisson approximation. Finally, in *Oceans and Islands: Physical Mapping of DNA*, he looked at a simple statistical model that yields formulas to predict progress of physical mapping projects that are made by overlapping random clones. The case of clones with characterized ends was also covered.

***Professor Arthur T. Winfree***
**University of Arizona**

**Arthur T. Winfree** is Regents Professor and Professor of Ecology and Evolutionary Biology at the University of Arizona. He obtained a Bachelor's degree in Engineering Physics from Cornell University and a Ph.D. in Biology from Princeton University. He began his academic career as Assistant Professor of Theoretical Biology at the University of Chicago before moving to Purdue University. He is at the University of Arizona since 1986.

Throughout his career, he has received a number of honours and awards. In 1981, he received the Japanese Society Promotion of Science Research Fellowship. He then received the John Simon Guggenheim Memorial Fellowship and the John D. and Catherine T. MacArthur Prize in theoretical biology. His contributions to cardiology were later recognized by the Einthoven Award given by the Netherlands Royal Academy of Sciences, the InterUniversity Cardiology Institute, and the Einthoven Foundation. Recently, he was awarded the Norbert Wiener Prize of 2000-2004 of the American Mathematical Society and the Society for Industrial and Applied Mathematics for innovations related to biological rhythms.

He has served on various editorial boards including Ecology & Ecological Monographs, Journal of Theoretical Biology, Physica D, International Journal of Chaos and Bifurcations, and Chaos. He has written three well-known books, including The Timing of Biological Clocks which was also published in French, German, Russian, Dutch, and Japanese. He also wrote more than 160 papers.

Professor Winfree's research has had a profound impact on the important field of biological rhythms, otherwise known as coupled non-linear oscillators. An experimental mathematician, he has set the agenda in that field. He was the first to determine the conditions under which a large population of coupled non-linear oscillators would synchronize. Many original ideas that have since borne mathematical fruit were put forth by Winfree in the course of this research. One was the reduced description of a population of weakly coupled non-linear oscillators in terms of the phase of each oscillator. In studying the entrainment of biological clocks by pulses of light, he realized that topological transitions might occur as the amplitude of the stimulus changes. This led to a topological classification that is used today to report the results of virtually every phase-resetting experiment on a biological system. It also led him to the realization that there must be special stimuli that would make a non-linear oscillator phaseless, i.e., stop the oscillation. His notion of a phase singularity has proved to be the key to the understanding of spiral waves in two-dimensional and of scroll waves in three-dimensional excitable media, such as cardiac tissue. The impact of these ideas on cardiac electrophysiology has been enormous; indeed, they completely define the field.

During his one-month stay, Dr. Winfree gave five talks. The first one, *Vortices in Motionless Media*, looked at how certain chemical gels and living heart muscle share an ability to excite in a way that propagates by chemical reaction or bioelectric currents. Both media support two modes of propagation: one in a rectilinear velocity, like sound or light, and one with an angular, rotational velocity, like a tornado, the latter causing sudden cardiac death. Much has been learned about it from the chemical analogy and the mathematical principles common to both. In *Unsolved Problems of the Heart*, he considers the two kinds of *action potential* of the electric behaviour of the heart muscle: the linearly propagating pulse of the textbooks, and alternative vortex-like solutions. The latter have many curious properties in three dimensions which are better understood by computation. The properties of rings in excitable media were further explored in *Linked and Knotted Vortex Rings in Excitable Media* and in *Some Challenging Puzzles Suggested by Vortices in Excitable Media.* Finally, Phase Patterns in Biological and Chemical Oscillators took a look at circadian body clocks whose synchronization by the light/dark cycle determines a global pattern, with singularities at the poles. Chemical oscillators also exhibit phase patterns in three-dimensional space. These seemed hard to observe, but there is a computationally intensive optical trick that makes it easy. Filaments of phase singularity are seen.

# General Programme 2000-2001

**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.**

## *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 was read and discussed publicly. The paper is *The Estimating Function Bootstrap* of John D. Kalbfleisch (Waterloo) and Heifang Hu (Singapore). The paper was 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, was a first for the *Canadian Journal of Statistics*. More than 100 participants attended the event.

## 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.)

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

**June 18 - July 7, 2000**
**Org. : Dana Schlomiuk (Montréal), Luc Bélair (UQAM)**

Invited participants F. Dumortier (Limburgs Universitairt Centrum, Diepenbeck, Belgium), J-P. Françoise (Université de Paris VI), Yu. Il'yashenko (Moscow Independent University and Cornell University), J. Llibre (Universitat Autònoma de Barcelona), C. Miller (Ohio State University), R. Moosa (Univ. of Ill. Urbana), A. Mourtada (Univ. de Bourgogne), P.-P. Rolin (Université de Bourgogne), Ch. Rousseau (Univ. de Montréal), P. Speissegger (Univ. of Wisconsin), H. Zhu (Univ. of Waterloo), A.Buium (Steklov Institute of Mathematical Sciences and Univ.Louis Pasteur Strasbourg), A.Buium (Univ. of New Mexico), Vadim Kaloshin (Courant Institute), S. Yakovenko (Weitzmann Institute of Science).

Les séries asymptotiques jouent un rôle important en équations différentielles et en dynamique nonlinéaire. Elles contiennent des informations précieuses sur les solutions des équations et sur la dynamique.

Basée sur les travaux de Ellis Kolchin et Joseph Fels Ritt, l'algèbre différentielle moderne est présentement un domaine très actif de recherche. À l'intérieur de cette discipline, qui a eu comme point de départ l'étude des transcendantes définies par les équations différentielles, on distingue deux directions: la théorie de Galois différentielle dont la théorie moderne part d'un travail de Kolchin (1948) et la géométrie algébrique différentielle ayant comme point de départ un travail de Ritt (1938.)

Les problèmes de finitude en dynamique nonlinéaire qui depuis longtemps ont défié les mathématiciens, impliquent l'usage des séries asymptotiques et entraînent des relations avec l'algèbre différentielle.

Le thème de l'Atelier fut celui d'explorer et approfondir les interconnexions entre ces trois directions de recherche ainsi que leurs applications aux problèmes de finitude en systèmes dynamiques nonlinéaires.

Un autre but de l'Atelier a été celui de familiariser les chercheurs de ces disciplines avec les travaux des spécialistes en théorie des modèles qui ont introduit des nouvelles approches portant sur le thème de l'Atelier (exemples sont: la notion de o-minimalité ainsi que les travaux de van den Dries sur la classe universelle des transséries d'Ecalle) et donner la possibilité à des spécialistes en théorie des modèles de discuter avec les autres participants.

Le programme a été conçu de sorte à permettre de nombreuses discussions. De nouveaux travaux de collaboration ont été initiés durant les trois semaines de l'Atelier et ces collaborations se sont poursuivies après. L'étendue du thème ainsi que la participation des spécialistes à orientations différentes mais ayant des problèmes reliés a engendré une atmosphère qui fut très stimulante.

En début d'atelier, cinq mini-cours furent présentés au bénéfice des étudiants gradués et des chercheurs nouveaux dans le domaine: Andrey Bolibrukh (5 heures) *Asymptotic series and Differential Equations*; Alexandru Buium (5 heures) *Differential algebraic geometry and Diophantine Geometry*; Vadim Kaloshin (5 heures) *Finiteness Theorems in Dynamical Systems*; L. Van den Dries (4 heures) *Logarithmic-exponential series and o-minimality*; Sergei Yakovenko (5 heures) *Quantitative Theory of Ordinary Differential Equations and tangential Hilbert 16th problem*.

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

## Histoires de structures et de catégories

**August 10, CRM**
**Org. : Michael Barr (McGill) & Liliane Beaulieu (CRM)**

Le développement des mathématiques du vingtième siècle a été marqué par les concepts unificateurs de *structures* et *catégories*. Toutefois la valeur des théories que ces termes ont désignées, quant à elle, fait encore l'objet de controverses rétrospectives dans la communauté des mathématiciens. Cet atelier, qui réunit mathématiciens, historiens et philosophes des mathématiques, s'est donné pour objectif de faire le point sur les histoires des structures et de la théorie des catégories. Par son contenu, cet atelier se situe dans le prolongement des ateliers d'apprentissage et du séminaire qu'ont organisés Luc Bélair (UQAM) et Jean-Pierre Marquis (Montréal) en 1998, 1999 et 2000.

À ce jour, les historiens qui se sont penchés sur I'histoire des structures ont surtout parlé de I'histoire de différentes structures mathématiques. Peu de travaux se sont intéressés au développement du concept général de structure, comme notion mathématique ou métamathématique. L'histoire de la théorie des catégories, pour sa part, est encore à faire, mais puisque plusieurs protagonistes du développement de cette théorie peuvent livrer leurs témoignages, il convient de leur donner d'abord la parole. En outre, nous sommes intéressés à I'essor des catégories en Amérique du Nord, en général, et dans les universités montréalaises, en particulier.

Les principaux exposés de ce cette année furent: Michael Barr (McGill) *Category theory and homological algebra*, Jean-Pierre Marquis (Montréal) *Classes, universaux et types: structures catégoriques et structures conceptuelles*, Colin McLarty (Case Western) *Categories along the Seaway*.

Un deuxième volet est prévu pour I'année 2000-2001. Voir la rubrique *Activités futures* de ce rapport.

## 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 and UQAM), Adriano Garsia (UCSD), Pierre Lalonde, Christophe Reutenauer (Strasbourg,UQAM), 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, marquait, 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 était de faire le point sur quelques-uns de ces développements en réunissant des experts internationaux de ces domaines. Nous souhaitions également donner la chance aux chercheurs jeunes ou plus expérimentés de faire connaître leurs résultats récents. Le programme comprenait dix conférences plénières ainsi que des communications sélectionnées par le comité scientifique. Afin de favoriser une plus grande interaction, ces communications ont été 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.

## XII$^{th}$ 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 12$^{th}$ 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 included 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). Bodil Branner (Technical University of Denmark), Wellington de Melo (IMPA), Raphaël Douady (CNRS, ENS de Cachan), John Hubbard (Cornell Univ.), Mikhail Lyubich (SUNY - Stony Brook), John Milnor (SUNY - Stony Brook), Raghavan Narasimhan (Univ. of Chicago), Curtis McMullen (Harvard), Mitsuhiro Shishikura (University of Hiroshima).**

This conference was held to celebrate the 65th birthday of Adrien Douady and to highlight his numerous important contributions to mathematics, most notably to dynamical systems and to analytic geometry. The two-day event had a large turnout, who came to hear some very eminent speakers discuss their work and its relation to Adrien Douady's. Talks included B.Branner, *Quasi-conformality and surgery in holomorphic dynamics*, R.Douady, *EDP, controle stochastique et evaluation des options*, J.Hubbard, *Exploring the parameter space for Henon mappings*, M.Lyubich, *Quadratic-like maps, complex renormalization, and their implications*, C.McMullen, *Dynamics on K3 surfaces*, W. de Melo, *Regular or stochastic dynamics in real analytic families of unimodal maps*, J.Milnor, *Dynamics and the brain*, R.Narasimhan, *Gromov's elliptic Oka principle*, M. Shishikura, *Thurston's algorithm for exponential maps.*

## A Series of Conferences by Professor Alexei Miasnikov

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

This was a series of ten lectures on equations over free groups and free semigroups. In theoretical computer science, this topic is known as the unification problem. Professor Miasnikov discussed recent developments in this area related to algebraic geometry over groups, Tarski's problems, and complexity of the unification problem.

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

**March 23 - 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)**

The Symplectic Topology, Geometry and Gauge January 2001 to June 2001 was the very first thematic program organised jointly by the Fields Institute and the CRM.

At the moment of writing these lines, the semester still had a month and a half to go – the last workshop on Hamiltonian Group Actions and Quantization had not yet taken place. But it is certainly not premature to say that this semester has been a success from many points of view.

First of all, the subject itself is amongst the deepest and most exciting areas of research in pure mathematics and in theoretical physics. Symplectic geometry is a classical subject, whose roots go back to the development of analytical mechanics by the French school in the eighteenth century. But gauge theory and symplectic topology are much more recent: the former was introduced in physics in the middle of the century, while symplectic topology really began in the seventies when the first case of the famous Arnold conjectures was solved. The mathematical development of the former received a definitive impulse when Donaldson applied gauge theoretic methods to the study of four-dimensional topology. The introduction of the pseudoholomorphic method by Gromov in 1985 had a similar effect on symplectic topology. Taubes' recent work on the Seiberg-Witten invariants has established a strong link between the two fields.

The joint FI-CRM program was the main international event on these subjects to take place in 2000-2001. It was preceded by the program on Infinite Dimensional Lie Theory and Its Applications. As a bridge between the two programs, Eckhard Meinrenken gave a graduate course on Symplectic Geometry during the first semester.

The first activity of Symplectic Topology, Geometry and Gauge Theory Program was the workshop on Quasiclassical and Quantum Structures held from January 9 to 14, 2001, organised by Etingof and Khesin. The main topics included classical and quantum integrable systems, Macdonald theory, Poisson-Lie groups, quantum groups, and quantization of infinite dimensional Lie algebras. It attracted some of the best mathematicians and mathematical physicists: Kac, Jimbo, A. Kirillov, Miwa, Reshetikhin, and many others. The interplay between algebra and geometry, between mathematics and physics gave rise to very stimulating discussions.

During the two months from mid-January to mid-March, three graduate courses were given by Jeffrey, Khesin, and Meinrenken, and a week of lectures by Eliashberg. With about eight postdoctoral fellows and many long-term visitors, these activities were an essential part of the program. The courses covered the following topics: Symplectic Geometry and Hamiltonian Group Actions by Jeffrey; Infinite Dimensional Lie Groups and Gauge Theory by Khesin; Moduli Spaces of Flat Connections by Meinrenken; and finally an introduction to Symplectic Field Theory by Eliashberg. This minicourse by Eliashberg was splendid: it ran from Monday to Friday, 2 hours a day, and covered the essential features of Symplectic Field theory. This theory was introduced very recently by Eliashberg, Givental and Hofer, and aims to give an extension of the usual notion of Gromov-Witten invariants when one replaces a closed symplectic manifold by a symplectic manifold whose boundary realises a cobordism between contact manifolds. The theory intertwines contact homologies (Eliashberg), homological algebras (Givental) and symplectic homologies (Floer-Hofer). It has some very interesting applications to invariants and obstructions in symplectic topology and contact geometry.

The long-awaited two-week workshop on Symplectic and Contact Topology, Quantum

Cohomology, Symplectic Field Theory and Higher-Dimensional Gauge Theory was held from March 23 to April 7. The first week took place at the Fields Institute and the second week at the CRM. It was organised by Donaldson, Eliashberg, Givental, Khesin, and Lalonde. The organisers reserved two full VIA rail cars with meals to take the participants from Toronto to Montreal during the weekend between the two weeks. This workshop was definitely one of the highlights of the year in symplectic geometry and topology. It gave rise to lots of interactions, discussions, and joint works that were taking place everywhere, even in the train. Its main goal was to discuss the recent developments in the construction and computations 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, manifest the existence of surprising correspondences between various gauge theories on real and complex manifolds. The level of maturity and clarity that the whole field has now attained, the fecundity of its applications and the depth of its conceptual framework are the striking features of this year's event. The workshop was such a success that we had to limit the number of applicants – the rooms were full both in Toronto and in Montreal – so that sometimes the workshop looked more like a conference. Some of the main speakers included Auroux, Chekanov, Eliashberg, Fuchs, Fukaya, Getzler, Kotschick, McDuff, Parker, Polterovich, Salamon, Sikorav and many others. The organisers have decided to publish the proceedings of that workshop in the Fields Institute Communications Series.

The last workshop on Hamiltonian Group Actions and Quantization will be held from June 4 - 13, 2001. It is organised by Audin, Hurtubise, Jeffrey, and Meinrenken. The main topics include geometric quantization and the Guillemin-Sternberg conjecture, generalized moment map theories, symplectic cobordisms, relation with geometric invariant theory, cohomology rings of symplectic quotients, and flat connections on Riemann surfaces. The list of speakers can be found on the Fields website. **(http://www.fields.utoronto.ca/programs/scientific/00-01/symplectic/hamiltonian/)**

The participants were especially pleased by the quality of the work done by the staff and the kindness of the welcome that they received both in Toronto and in Montreal. I would like to take this opportunity to thank Alison Conway and Elena Kaufman at the Fields Institute, and Louis Pelletier and Josée Laferrière at the CRM.

## Knots in Montreal

**April 7-8, 2001**
**Org.: S. Boyer (UQAM) & A.S. Sikora (UQAM)**

This short conference brought together mathematicians interested in knot theory and 3-dimensional topology from Canada and the northern and eastern parts of the United States. It took place at the Université du Québec à Montréal.

Speakers included D. Rolfsen, *Orderable 3-manifold groups*, W. Menasco, Y. Rong, F. Luo, *Grothendieck's reconstruction principle for SL(2) characters*. L. H. Kauffman, *Virtual Knot Theory and Detecting Knots with the Jones Polynomial* T. Mattman, *Seifert surgeries which do not arise from primitive/Seifert constructions* T. Kerler, *Integral TQFT's, cut-numbers, and the mapping class groups* J. Conant, *Grope cobordism of classical knots* J. H. Przytycki, *Lagrangian tangles in Fox coloring spaces and theirt-deformations*

# CRM Prizes

## CRM-Fields Prize

**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 (1995), G.A. Elliot (1996), J. Arthur (1997), R.V. Moody (1998), Stephen A. Cook (1999), and Israel Michael Sigal (2000). The CRM-Fields Institute 2001 Prize is awarded to *Dr. William T. Tutte*.**

**William T. Tutte** is Distinguished Professor Emeritus of Combinatorics and Optimization at the University of Waterloo. Professor Tutte received his education at Cambridge University, graduating with his Ph.D. in 1948. He then joined the faculty of the University of Toronto and moved to the University of Waterloo in 1962.

He is a Fellow of the Royal Societies of London and Canada, of the American Association for the Advancement of Science and of the New York Academy of Sciences. He also received a Killam Prize, the Tory Medal of the Royal Society of Canada, and was Jeffery-Williams Lecturer of the Canadian Mathematical Society. He was the Editor-in-Chief of the Journal of Combinatorial Theory during 17 years and is the Honorary Director of the Centre for Applied Cryptographic Research. He is the author of more than 160 articles and 5 books.

Professor Tutte's research is in graph theory and related areas of discrete mathematics, and he has done so for the last 60 years or so. This was the period of *coming of age* of graph theory; it changed from being a collection of rather easy theorems and some good open problems, to being a well-developed branch of mathematics, stocked with rich and deep results. There were only a few prime movers who brought this about; the ones that come to mind are Erdös, Wagner and Halin, and Tutte. Professor Tutte took the opportunity to do initial, groundbreaking work in several new areas that were later to grow to major fields of discrete mathematics.

Few theorems in mathematics are honoured by the general public by naming them after the mathematician who proved them. Professor Tutte's wide influence in the field of combinatorics can be illustrated by pointing out a number of results commonly named after him. For somebody working in matching theory, Tutte's Theorem means his characterization of regular graph having a perfect matching — for a matroid theorist, his characterization of regular matroids — for somebody studying Hamilton cycles, it means his result that every 4-connected planar graph has a Hamilton cycle. In algebraic combinatorics, there is the Tutte polynomial of a graph and of a matroid. The important complexity classification by Welsh and his group of many graphical enumeration problems uses the *Tutte plane.*

In summary, William Tutte grabbed all the best theorems while they were still up for grabs. But more than that; his work (both written and lecture) was really beautiful — it was always a fantastic experience to watch him take on some problem, apply some strange algebraic machinery to it, and make showers of consequences fall out, in the most elegant way.

## 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), and Changgeng Gui (1999). CRM was delighted to award the 2000 André-Aisenstadt Prize to *Dr. Eckhard Meinrenken* of the University of Toronto.**

**Eckhard Meinrenken** completed a Ph. D. in Physics at Freiburg University in 1994. He was a Postdoctoral Research Fellow at the Massachusetts Institute of Technology from 1995 to 1997 before becoming Assistant Professor of Mathematics at the University of Toronto in 1998. He was promoted to Associate Professor in 2000.

Professor Meinrenken works in symplectic geometry, a very active and rapidly expanding mathematical discipline whose roots lie in classical mechanics. He works on group actions arising as Hamiltonian flows on symplectic manifolds, and on symplectic quotients, symplectic manifolds formed by dividing out symmetries of a symplectic manifold with a group action. His first major result in that area came in 1994 when he proved a longstanding conjecture of Guillemin and Sternberg concerning the quantization of symplectic quotients, better known as *quantization commutes with reduction.* In collaboration with Sjamaar, Meinrenken has now extended his previous results to singular symplectic quotients.

A second important topic in Meinrenken's work was the development of techniques to study moduli spaces of flat connections on Riemann surfaces. His first approach (with Woodward) involved studying Hamiltonian actions of loop groups leading to a proof of the Verlinde formula. Another powerful approach (with Alekseev and Malkin) involves studying manifolds with group actions and a generalization of the moment map that takes values not in the dual of the Lie algebra, but in the corresponding Lie group. Finally, with Alekseev and Woodward, Professor Meinrenken has obtained generalizations of many of the standard results associated to manifolds equipped with Hamiltonian group actions, such as the convexity theorem, the localization formula for equivariant cohomology, and the Duistermaat-Heckman theorem.

Professor Meinrenken received his Prize on February 9, 2001 at CRM. He spoke on *Matrices, Moment Maps, and Moduli Spaces* where he explained the main properties of non-linear moment maps, a mathematical generalization of angular momentum in classical mechanics. He also discussed their applications to eigenvalue problems for matrices and to moduli spaces of flat connections over a surface.

## 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 (1995), William G. Unruh (1996), Ian Affleck (1997), J. Richard Bond (1998), David J. Rowe (1999), and Gordon W. Semenoff (2000). The 2001 CRM-CAP prize has been awarded to *Dr. André-Marie Tremblay*.**

**André-Marie Tremblay** is Professor at Université de Sherbrooke. He holds a B.Sc. from Université de Montréal and a Ph.D. from the Massachusetts Institute of Technology. After a two-year postdoctoral fellowship at Cornell University, he joined the Physics Department at Université de Sherbrooke.

Professor Tremblay was awarded the Herzberg Medal of the Canadian Association of Physicists (CAP) in 1986, the Steacie Fellowship from NSERC in 1987, and a Killam Fellowship from 1992-1994. He is a member of the Canadian Institute for Advanced Research and holds a Canada Research Chair on the Condensed Matter Physics at Université de Sherbrooke. He is the author of over one hundred publications in well-known scientific journals.

The CRM-CAP Prize in Theoretical and Mathematical Physics was awarded to Professor Tremblay for his outstanding contributions to theoretical condensed matter physics, including progress on the challenging problem of understanding the behavior of strongly correlated electron systems. André-Marie Tremblay is well known for his original contributions to the theory of solids over the last twenty years. He has developed several theoretical methods aimed at predicting the behaviour of electrons in, among other things, metals, disordered materials, and superconductors. He is one of the inventors of the multifractal concept, inspired by Mandelbrot's fractal geometry and applied to the percolation phenomenon in disordered media. His more recent work on the effect of electron-electron interactions in solids has contributed to our understanding of high-temperature superconductivity. In particular, he has developed efficient theoretical methods for the study of physical systems in which conduction electrons are strongly correlated, that is, in which they interact too strongly to be treated as free particles, but not strongly enough to be completely localized.

## 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. Previous winners were Christian Genest (1999) and Robert Tibshirani (2000). This year, the Centre de recherches mathématiques and the Statistical Society of Canada have awarded the CRM-SSC 2001 Prize in Statistics to *Dr. Colleen Cutler* of the University of Waterloo.**

**Colleen Cutler** grew up in Manitoba where she received her early schooling. She received a Bachelor of Science degree from the University of Manitoba, and Masters and PhD degrees from Carleton University, the latter in 1985 under the supervision of Donald Dawson. She was on faculty in the Department of Statistics at the University of Manitoba from 1983-1986. Since 1986 she has been a faculty member in the Department of Statistics and Actuarial Science at the University of Waterloo, where she holds the rank of Professor.

Professor Cutler's work has been recognized in various ways. Among the major invited presentations that she has delivered, note the IMS Special Invited Paper at the 7th Vilnius Conference on Probability Theory and Mathematical Statistics / 22nd European Meeting of Statisticians and SPA 98, the 25th International Conference on Stochastic Processes and their Applications sponsored by the Bernoulli Society.

Dr. Cutler's work has had a very substantial impact in probability and statistics, but also in other areas of science. It is particularly noteworthy that she has published in some of the very best journals of statistics and probability, but also of mathematics and physics, including review papers that have reached a broad readership and helped a lot to spread out knowledge to researchers outside the mathematics and statistics communities. Her fundamental results on fractal dimensions and their estimation are major contributions at the interface between dynamical systems and statistics, and are well known by physicists and other scientists. She was a pioneer in the rigorous mathematical study of the relations of these quantities and their statistical estimation where much of the published research was empirical or intuitive. She has also made important contributions to the problem of distinguishing between stochastic and deterministic chaotic time series. Finally, her work on the scaling behaviour of probability measures is widely used and cited by mathematicians.

# 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**

## Post-doctoral Fellows Seminar

**Org.: Pietro-Luciano Buono (CRM)**

**March 7, 2001**
Pietro-Luciano Buono, CRM
*Equivariant Bifurcation Theory*

**March 28, 2001**
Marco Bertola, CRM
(*Nonperturbative) Quantum Field Theory in presence of Gravitation*

**April 11, 2001**
Steve Allen, CRM
*Contours actifs géométriques en imagerie: théorie et applications*

## Seminar in Non-linear Analysis

**Org.: Marlène Frigon, (Univ de Montréal)**

**October 4, 2000**
Nicolas Beauchemin, Univ. de Montréal
*Introduction à la théorie des points critiques multivoques*

**October 18, 2000**
Nicolas Beauchemin, Univ. de Montréal
*Introduction à la théorie des points critiques multivoques II*

**October 25, 2000**
Tomasz Kaczynski, Univ. de Sherbrooke
*L'indice de Conley d'une application continue: de la théorie au calcul*

**November 1, 2000**
Paul Deguise, Univ. de Moncton
*Introduction aux applications KKM*

**November 8, 2000**
Iddris Addou
*Nombre de solutions de problèmes aux limites elliptiques quasi-linéaire par la méthode de quadratures*

**November 22, 2000**
Nicolas Beauchemin, Univ. de Montréal
*Méthodes variationnelles appliquées aux inclusions aux dérivées partielles*

**November 29, 2000**
Nicolas Beauchemin, Univ. de Montréal
*Méthodes variationnelles appliquées aux inclusions aux dérivées partielles II*

**December 6, 2000**
Emmanuel Montoki, Univ. de Montréal
*Méthodes topologiques appliquées aux équations différentielles du second ordre*

**December 13, 2000**
Emmanuel Montoki, Univ. de Montréal
*Méthodes topologiques appliquées aux équations différentielles du second ordre II*

**January 15, 2001**
A. Granas, Univ. de Montréal
*Théorie des ANR's et analyse non linéaire*

**January 23, 2001**
A. Granas, Univ. de Montréal
*Théorie des ANR's et analyse non linéaire II*

**January 31, 2001**
Emmanuel Montoki, Univ. de Montréal
*Equations différentielles du second ordre avec opérateur monotone*

**February 7, 2001**
Emmanuel Montoki, Univ. de Montréal
*Equations différentielles du second ordre avec opérateur monotone II*

**February 21, 2001**
Alexandre Girouard, Univ. de Montréal
*Introduction à l'homologie relative*

**February 28, 2001**
Salem Rabhi, Univ. de Montréal
*Solutions des équations elliptiques et indice de Morse*

**March 7, 2001**
Paul Deguise, Univ. de Moncton
*Quelques résultats en théorie de coincidence*

**March 14, 2001**
Salem Rabhi, Univ. de Montréal
*Solutions des équations elliptiques et indice de Morse*

**March 21, 2001**
A. Granas, Univ. de Montréal
*Prolongement d'applications compactes et le principe de Leray-Schauder dans les ANRs.*

**March 28, 2001**
A. Granas, Univ. de Montréal
*Prolongement d'applications compactes et le principe de Leray-Schauder dans les ANRs. II*

**April 11, 2001**
Noha El Khattabi, Univ. Mohamed V, Rabat
*Sur et sous-solutions dans la théorie des équations différentielles*

**April 25, 2001**
Alexandre Girouard, Univ. de Montréal
*Théorie de Morse en analyse non linéaire*

**May 2, 2001**
A. Granas, Univ. de Montréal
*Théorèmes de point fixe dans les ANRs*

**May 16, 2001**
Alexandre Girouard, Univ. de Montréal
*Inégalités d Morse*

**May 30, 2001**
Alexandre Girouard, Univ. de Montréal
*Applications de la théorie de Morse aux équations différentielles*

## Analysis Seminar CRM-ISM

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

**June 2, 2000**
Javad Mashreghi, McGill Univ.
*Paley-Wiener Functions on the Real Line*

**June 9, 2000**
Alexandre Girouard
*Volume de la n-boule et mesure de Hausdorff*

**June 16, 2000**
Richard Fournier, CRM
*Sur le lemme de Jack*

**June 23, 2000**
Jean-Philippe Samson
*Sommation complexe de séries réelles*

**July 21, 2000**
Dominic Rochon, Univ. de Montréal
*Dynamique bicomplexe »*

**July 28, 2000**
Marta Kosek Univ. Jagiellónski
*Extremal function of Julia Type sets in Cm*

**August 25, 2000**
Sébastien Manka, DMS
*Familles normales et théorème de Picard*

**September 1, 2000**
Eduardo Zeron, CRM
*Topology of rationally convex sets*

## Study Workshop: Physique mathématique (Systèmes intégrables)

**Org.: John Harnad & Marco Bertola (CRM & Univ. de Montréal)**

**September 28, 2000**
Alexey Kokotov
*C-* algebras of pseudodifferential operators inpolyhedrons*

**November 30, 2000**
Henning Samtleben
*Gauged supergravity in three dimensions*

**December 7, 2000**
Dmitri Scherbin, CRM
*Fermionic represenation for basic hypergeometric functions related to Schur polynomials*

## The Langlands Geometric Programme

**Org.: Jacques Hurtubise (McGill)**

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

**January 27, 2000**
Eyal Z. Goren, McGill Univ.
*Vector Bundles, II*

**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, McGill Univ.
*Correspondance Fonctions-faisceaux*

## Seminar in Mathematical Physics

**Org.: John Harnad & Marco Bertola (CRM & Univ. de Montréal)**

**September 19, 2000**
Hartmut Fuehr, Technische Univ.
*Continuous Wavelet Transforms and Plancherel Theory of Locally Compact Groups*

**September 26, 2000**
Ametepe Lionel Hohoueto, Concordia Univ.
*Coherent States lattices of Semi-direct Product Groups*

**October 3, 2000**
Marco Bertola, CRM & Concordia Univ.
*Mass Spectra Generation by dimensional reduction*

**November 14, 2000**
Xifang Cao, CRM & Univ. Yangzhou
*Bäcklund transformations on Weingarten surfaces*

**November 28, 2000**
Anatole Odzijewicz, Univ. of Bialystok, Poland
*Multiboson computations using Hahn polynomials*

**January 9, 2001**
Jorgen Rasmussen, Univ. of Lethbridge
*su(N) tensor product multiplicities and virtual Berenstein-Zelevinsky triangles*

**January 23, 2001**
Luc Frappat, CNRS, LAPP
*Elliptic algebras, q-deformed W-algebras and Yangian limits*

**January 30, 2001**
Bertrand Eynard, SPHT Saclay (France)
*Random matrices and (skew)-orthogonal polynomials*

**February 6, 2001**
J. Harnad, CRM & Concordia Univ.
*Multi-Hamiltonian structures, R-matrices and spectralseparation of variables I*

**February 13, 2001**
Bertrand Eynard, SPHT Saclay (France)
*Random Matrix 0(n) Model*

**February 20, 2001**
Jacques Hurtubise, CRM & McGill Univ.
*Multi-Hamiltonian structures, R-matrices and spectral separation of variables, II*

**February 27, 2001**
Oksana Yermolayeva, CRM & Concordia Univ.
*A review of the f-g method in orthogonal polynomials*

**March 13, 2001**
A. Zhedanov, CRM & Univ. Donetsk
*Integrable chains, algorithms and orthogonality I*

**March 20, 2001**
A. Zhedanov, CRM & Univ. Donetsk
*Integrable chains, algorithms and orthogonality II*

**March 22, 2001**
C. Klein, Eberhard-Karls-Universität, Tübingen
*Relativistic dust disks and hyperelliptic Riemann surfaces*

**March 27, 2001**
Paul Bracken, CRM
*Symmetries, Integrability and MultiSoliton Solutions of the Generalized Weierstrass System*

**April 3, 2001**
Chongying Dong, Univ. of California, Santa Cruz
*Monster, Moonshine and Vertex (Operator) Algebras*

**April 10, 2001**
Dmitri Korotkin, CRM & Concordia Univ.
*Isomonodromic deformations and Hurwitz spaces: tau-function and determinant of Laplacian operator I*

**April 17, 2001**
Dmitri Korotkin, CRM & Concordia Univ.
*Isomonodromic deformations and Hurwitz spaces: tau-function and determinant of Laplacian operator II*

**April 24, 2001**
Anna Krasowska, Concordia Univ.
*Wigner functions for semidirect product groups Rn \rtimes H*

**May 1, 2001**
Marco Bertola, CRM & Concordia Univ.
*Duality in Random Matrices and Biorthogonal Polynomials*

## CRM Statistics Seminar

**Org.: Christian Léger, Martin Bilodeau (CRM & Univ. de Montréal)**

**September 6, 2000**
Djamal Louani, Univ. de Paris VI
*Some applications of Large Deviations Results in Nonparametric function estimation*

**September 14, 2000**
Martin Bilodeau, Univ. de Montréal
*Inférence robuste en analyse multivariée*

**September 28, 2000**
David B. Wolfson, McGill Univ.
*Problems and solutions associated with length-biased sampling*

**October 5, 2000**
Bruno Rémillard, Univ. du Québec à Trois-Rivières
*Un test non paramétrique d'indépendance sérielle pour des séries chronologiques*

**November 2, 2000**
Xiang Sun, Ontario Cancer Institute
*The lasso's implementation for neural networks*

**November 23, 2000**
Josée Dupuis, Genome Therapeutics Corporation
*Linkage Analysis of the Pseudoautosomal Regions*

**November 23, 2000**
Eric Kolaczyk, Boston Univ.
*A Multiresolution Analysis for Likelihoods*

**December 7, 2000**
Geneviève Gauthier, HEC
*Estimation par la méthode du maximum de vraisemblance des paramètres du modèle de risque de crédit de Merton*

**February 8, 2001**
Nicolas Molinari, IURC , Univ. Montpellier 1
*Optimisation des noeuds en régression spline: applications aux Biostatistiques*

**February 15, 2001**
Jonathan Taylor, McGill Univ.

*Processus gaussiens non-stationaires indexés par des surfaces avec applications à l'imagerie cérébrale*

**February 22, 2001**
Gérard Biau, McGill Univ.
*Estimation minimax d'un système dynamique chaotique mutlidimensional*

**March 1, 2001**
Christian Boudreau, Univ. of Waterloo
*Analyse de Survie et Plans d'Échantillonnage non Informatifs*

**March 22, 2001**
Louis-Paul Rivest, Univ. Laval
*Modèle de capture-recapture pour l'estimation de la taille d'une population finie*

**March 27, 2001**
Hung Thao Tran, Institut de Mathematiques du Viet Nam
*Processus de type ARIMA fractionnaire*

**April 19, 2001**
Robert Tibshirani, Univ. Stanford
*Statistical challenges in the analysis of DNA microarray data*

## Special Lectures

**Org. : Jacques Hurtubise (CRM)**
**June 19, 2000**
Michel Monastyrsky, Instiute of Theoretical and Experimental Physics
*Topological Problems in Physics*

**June 21, 2000**
Michel Monastyrsky, Instiute of Theoretical and Experimental Physics
*Statistics of Knots and some relations with random walks on Riemann surfaces and 2-dimensional conformal models*

**Org. : Michel Delfour, Univ. de Montréal**
**November 3, 2000**
Marc Thiriet, INRIA Rocquencourt, France
*Sur les endoprothèses*

**Org.: Michel Delfour (UdeM) and André Bandrauk (Sherbrooke)**
**December 11, 2000**
Claude Le Bris (CERMICS, Ecole Nationale des Ponts et Chaussées)
*Théorie du contrôle et méthodes d'optimisation en sciences moléculaires*

**Org.: Jean-Marc Lina**
**January 16, 2001**
Raouf Hamzaoui, University of Leipzig
*Complexity Reduction Methods for Fractal Image Compession*

## Dynamical Systems Days

**Org. : Dana Schlomiuk & Christiane Rousseau (Univ. de Montréal)**

**November 21, 2000**
Nicolae Vulpe, Académie des sciences de Moldavie
*Applications of Algébraic Invariants in the Qualitative analysis of two-dimensional Polynomial Differential Systems*

**November 21, 2000**
Joan Carles Artes, Univ. Autonoma de barcelona, Espagne
*Structurally Stable quadratic Systems*

**November 21, 2000**
Pavao Mardesic, Univ. de Bourgogne, France
*Complex Isochonous Saddle Points*

**November 22, 2000**
Dana Schlomiuk, Univ. de Montréal
*Classifying Quadratic Systems*

**November 22, 2000**
Christianne Rousseau, Univ. de Montréal
*The Meaning of the Martinet-Ramis Invariants in the Unfolding of a Saddle-node*

## CRM-EJC Colloquium

**Org. : Christiane Rousseau (Univ. de Montréal)**
**October 5, 2000**
Francis Clarke, Institut Desargues, Univ. Lyon I
*Modélisation bioéconomique des ressources renouvelables*

# 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 2000

**September 8, 2000**
Arthur Winfree, Univ. of Arizona
*Vortices in Motionless Media*

**September 15, 2000**
Ram Murty, Queen's Univ.
*The Rieman Hypothesis: A Statut Report*

**September 22, 2000**
Michael Cahen, Univ. Libre de Bruxelles
*A conjecture on symplectic connections*

**October 6, 2000**
Clauss Michael Ringel, Univ. de Bielefeld
*Combinatorial representation theory - history and future*

**October 20, 2000**
Mikhail Lyubich, SUNY - Stony Brook
*Quadratic-like maps, complex renormalization, and their implications*

**October 27, 2000**
Avner Ash, Boston College
*The Galois group of the field of algebraic numbers*

**November 3, 2000**
Konstantin Mischaikow, Georgia Institute of Technology
*Competition, Dispersal, and Spatiotemporal Heterogeneity*

**November 10, 2000**
Israel Michael Sigal, Univ. of Toronto
*Renormalization Group Approach to Spectral Problems with Application to Theory of Radiation*

**November 17, 2000**
Walter Neumann, Columbia Univ.
*Hilbert's 3rd problem and invariants of 3-manifolds*

**November 24, 2000**
Monique Jeanblanc, Univ. Evry
*Assurance de portefeuille*

**December 1, 2000**
Marco Avellaneda, Courant Institute
*Financial Modelling and Probability*

## Winter 2001

**February 2, 2001**
Damien Roy, Univ. d'Ottawa
*Interpolation en plusieurs variables*

**February 9, 2001**
Eckhard Meinrenken, Univ. of Toronto
*Matrices, Moment Maps, and Moduli Spaces*

**February 16, 2001**
Andrew Granville, Univ. of Georgia
*The distribution of multiplicative functions and integral delay equations*

**March 2, 2001**
William Duke, Rutgers Univ.
*Recent directions in analytic number theory*

**March 16, 2001**
Serge Lang, Yale Univ.
*Heat kernels, theta functions and zeta functions*

**March 23, 2001**
Michael Waterman, Univ. of Southern California
*Reading DNA Molecules*

**March 30, 2001**
Stephen Watson, York Univ.
*Existential Quantifiers in the Uncountable*

**April 6, 2001**
Joel Smoller, Univ. of Michigan
*Shock Waves in General Relativity*

**April 12, 2001**
Leonid Polterovich, Tel Aviv Univ.
*Kick stability in groups and dynamical systems*

**April 19, 2001**
Rob Tibshirani, Stanford Univ.
*Statistical challenges in the analysis of DNA microarray data*

**April 27, 2001**
Robert Sedgewick, Princeton Univ.
*New research on the theory and practice of sorting*

**May 4, 2001**
Dominic Welsh
*The Complexity of Some Classical Polynomials*

# 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?

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

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

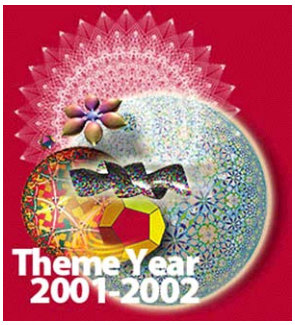
## Theme Year 2001-2002: Groups and Geometry

### 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 (Univ. 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 Univ. of New York at Buffalo).

### Mini-courses

**July 2 – 6, 2001**

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

Martin Bridson (Univ. of Oxford)
*Non-positively Curved Spaces and Hyperbolic Groups*

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

Benson Farb (Univ. of 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**
**Org.: Dani Wise (Brandeis & McGill)**

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 that 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***
  **V. Guillemin (MIT) & 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

**June 2002**

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), 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.

* To be confirmed

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. Haiman (California, San Diego), G. J. Heckman (Nijmegen), A. G. Helminck (North Carolina State), 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), 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

# General Programme 2001-2002

## Second *Canadian Journal of Statistics* Read Paper Session

**June 7, 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 Mary Lindstrom (Wisconsin), Jim Ramsay (McGill), Nancy Heckman (UBC), and Hugh Chipman and Hong Gu (Waterloo). 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 Souganidis, *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)**

Invited speakers: P. Bleher (IUPUI), A. Bourget (McGill), W. Craig (McMaster), H. Donnelly (Perdue), E. Duenez (American Institute of Mathematics), B. Eynard (CRM, Montréal), V. Jaksic (Ottawa), J. Harnad (CRM, Montréal), L. Ma (Tsinghua), K. McLaughlin (Arizona), M. Min-Oo (McMaster), Y. Petridis (McGill), I. Rivin (Temple), Z. Rudnick (Tel Aviv), P. Sarnak (Princeton), U. Smilansky (Weizman Institute), K. Soundararajan (IAS), R. Speicher (Queens), T. Tate (Johns Hopkins), A.Uribe (Michigan), I. Vardi (Le Bois-Marie), H. Widom (UC Santa Cruz), S. Zelditch (Johns Hopkins).

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.

## Histoires de structures et de catégories

**September 2001, CRM**
**Org. : Luc Bélair (UQAM) & Liliane Beaulieu (CRM)**

Invited speakers: L. Beaulieu (CRM), M. Bunge (McGill), C. Houzel (Paris), A. Joyal (UQAM), J. Lambek (McGill), M. Makkai (McGîll), C. McLarty (Case Western), G. Reyes (Montréal).

Cet atelier, qui réunit mathématiciens, historiens et philosophes des mathématiques, s'est donné pour objectif de faire le point sur les histoires des structures et de la théorie des catégories. Il s'agira aussi de combler certaines lacunes d'une historiographie qui a négligé de montrer les liens entre les développements de différentes branches des mathématiques et la quête pour cerner, d'un point de vue strictement mathématique ou d'un point de vue métamathématique, le principe collectivisant des *structures* ou des *catégories*. Comme l'an passé, la parole sera également donnée aux protagonistes de ces histoires.

## Constance van Eeden's Conference: Mathematical Statistics 2002

**May 24 – 25, 2002, CRM**
**Org. : Marc Moore (École Polytechnique), Sorana Froda (UQAM), Christian Léger (Montréal and CRM)**

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. It will feature invited talks by Roelof Helmers (CWI,

Amsterdam), Chris A.J. Klaassen (University of Amsterdam), Denis Larocque (HEC), Louis-Paul Rivest (Université Laval), Bill Strawderman (Rutgers University), and Jim Zidek (UBC). There will be a banquet on Friday night. 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

David Avis (McGill), Yoshua Bengio (Montréal), Gilles Brassard (Montréal), Luc Devroye (McGill), Pierre L'Ecuyer (Montréal), Pierre McKenzie (Montréal), Prakash Panangaden (McGill), Bruce Reed (McGill), Denis Thérien (McGill.)

## Overview

The field of computation, formally born only last century but with roots that stretch back to Euclid, is now a mathematical discipline in its own right, with solid theoretical foundations on which are based its spectacular development. The CRM special year in the mathematics of computer science proposes to explore in depth a significant spectrum of the many sub-areas that are core 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 theoretical foundations of computer science have blossomed, and ideas from the area (like effectiveness, complexity and tractability) have grown to occupy an ever more important role in mathematics. More recently, a recurrent theme in many of the domains examined are probabilistic methods; these have permeated the whole of computer science, and so particular emphasis will be placed on the utilisation of these techniques, both in theoretical areas and in more applied ones such as simulation and machine learning.

## Summer School on Quantum Information Processing

**July 15-19, 2002**
**Org.: Gilles Brassard (Montréal)**

Lecturers: A. Ambainis, C.H. Bennett, G. Brassard, H. Buhrman, R. Cleve, C. Crépeau, *N. Gisin, P. Høyer, R. Laflamme, M. Mosca, A. Tapp, J. Watrous
*to be confirmed

Classical information theory is firmly rooted in the classical physics of Newton and Einstein. But the world is quantum mechanical. This has prevented us from tapping the full potential of physical reality for information processing purposes. For instance, quantum mechanics allows for unbreakable cryptographic codes and such a high level of parallelism in computation that a classical computer the size of the universe would be left behind. The goal of this school is to make the field of quantum information processing accessible to a general audience of mathematicians and computer scientists who have little or no familiarity with quantum mechanics.

## AISENSTADT CHAIR LECTURE SERIES

There will be three series of conferences associated with the Aisenstadt Chairs by Manuel Blum (Carnegie Mellon), Laszlo Lovasz (Microsoft Research), and Endre Szemeredi (Rutgers University).

## CONCENTRATION PERIODS

### Complexity theory, analysis of algorithms

**May-June 2002**
**Org.: Pierre McKenzie (Montréal), Denis Thérien (McGill)**

In May 2002, the 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. In addition, there will be several 1-week workshops on topics that lie at the core of the theory of computing. Each workshop will bring together a number of leading scientists who will present both expository lectures and state-of-the-art research.

*Lecture series on branching programs*
**May 13-17, 2002**
**Org.: Ingo Wegener (Dortmund)**

*ACM Symposium on Theory of Computing (STOC)*
**May 19-21, 2002**

*IEEE Conference on Computational Complexity*
**May 21-24, 2002**

*Randomness in Branching program*
**May 27-31, 2002**

Random techniques play an important role in computer science, through algorithms which give an efficient solution to problems for which no good deterministic solution is known, or through the probabilistic study of complexity. A

week will be devoted to this theme, starting with the links between probabilistic methods and branching programs.

*Verification and model-checking*
**June 3-7, 2002**

In the past ten years, theoretical work in the area of verification has started to bear fruit. The workshop will cover the major areas of this development, in particular those linked to model-checking.

*Descriptive complexity*
**June 10-14, 2002**

Invited speakers for the one-week workshops include: M. Ajtai, D. Barrington, P. Beame, P.L. Crescenzi, R. Gavalda, N. Immerman, K.J. Lange, P. Pudlak, M. Sachs, R. Raz, P. Schnoebelen.

An area that has come to the fore in recent years, descriptive complexity gives a tool that complements more classical approaches to complexity theory. After a survey of the area, the workshop will concentrate on links between branching programs and algebraic structures.

## Quantum Foundations in the Light of Quantum Information

**October 13 – November 2, 2002**
**Org.: Gilles Brassard (Montréal), Christopher A. Fuchs (Los Alamos National Laboratory)**

Invited speakers include: H. Barnum, G. Brassard, H. Briegel, J. Bub, A. Cabello, C. Caves, *R. Cleve, C. Fuchs, N. Gisin, *D. Greenberger, L. Hardy, P. Hayden, A. Holevo (*), R. Jozsa, A. Kent, D. Mayers, D. Mermin, *T. Mor, M. Nielsen, A. Peres, I. Pitowsky, R. Schack, B. Schumacher, J. Smolin, R. Spekkens, *A. Steane, D. Wallace, W. Wootters, A. Zajonc.
* to be confirmed

Rolf Landauer's best-known aphorism is "information is physical". This workshop is centred around the belief that "physics is informational"! Our long-term purpose is to reformulate the foundations of quantum mechanics in the light of quantum information theory. Rather than being counterintuitive, could it be that quantum mechanics was inevitable for information to behave as we understand it now? For instance, what can we derive from the fact that unconditionally secure cryptographic key distribution is possible but bit commitment is not?

## Combinatorics, probability and algorithms

**May 2003**
**Org.: David Avis (McGill), Luc Devroye (McGill), Bruce A. Reed (McGill)**

Leave nothing to chance. This cliché embodies the common belief that randomness has no place in well-planned methodologies, every *i* should be dotted and every *t* should be crossed. In discrete mathematics, at least, nothing could be further from the truth. Introducing random choices into algorithms can improve their performance. The application of probabilistic tools has led to the resolution of combinatorial problems which have resisted attack for decades.

A month-long concentration period will take place around this general theme. Lecturers at the school will introduce participants to a number of weapons, mostly from the probabilistic arsenal, and their applications in combinatorics and in the study of algorithms. We anticipate a significant amount of collaboration between participants at the school during the month.

There will be 5 hour mini-courses given by: N. Alon (Technion), V. Chvatal (Rutgers), A. Frieze (Carnegie-Mellon), L. Lovasz, (Microsoft), C. McDiarmid (Oxford), M. Molloy (Toronto), J. Pach (City College New York and Hungarian Academy of Sciences).

## INTERNATIONAL ANNUAL MEETINGS

### ACM Symposium on Theory of Computing (STOC)

**May 19-21, 2002**

### IEEE Conference on Computational Complexity

**May 21-24, 2002**
**Org.: Pierre McKenzie (Montréal), Denis Thérien (McGill)**

These two conferences are part of the concentration period on Complexity theory, analysis of algorithms.

### Mathematical Foundations of Programming Semantics (MFPS)

**March 17-22, 2003**
**Org.: Prakash Panangaden (McGill)**

Conferences and workshops in this series, held annually since 1985, aim to provide a forum for researchers in all areas surrounding semantics to present their latest research results, and to improve communication and interactions between mathematicians and computer scientists who work in these areas. The areas of relevance

include category theory, domain theory, logic and topology on the mathematics side, and type theory, semantics, and the design and implementation of programming languages on the computer science side.

### IEEE Symposium on Logic in Computer Science (LICS)

**June 20-26, 2003**
**Org.: Amy P. Felty (Ottawa), Philip Scott (Ottawa)**

To be held at the University of Ottawa in 2003, the IEEE Symposium on Logic in Computer Science (LICS) is an annual international forum on theoretical and practical topics in computer science that relate to logic in a broad sense. The CRM will be sponsoring four satellite workshops for this conference.

## WORKSHOPS

### Random number generation and highly uniform point sets

**June 17-28, 2002**
**Org.: Pierre L'Ecuyer (Montréal)**

Invited speakers : G. Chaitin, C. Crépeau, L. Devroye, M. Evans, B.L. Fox, M. Fushimi, J. Gentle, P. Hellekalek, S. Heinrich, W. Hormann, A. Keller, G. Larcher, P. L'Ecuyer, J. Leydold, C. Lemieux, M. Mascagni, M. Matsumoto, S. Ninomiya, T.Nishimura, A.B. Owen, G. Pirsic, W. Schmid, I. Sloan, S. Tezuka, H. Wozniakowski, C. Xing.

This workshop will bring together the world leaders in the theoretical and practical aspects of random number generation by computer and the design of highly-uniform point sets for quasi-Monte Carlo integration. The general theme is the development of practical random number generation software for various classes of applications, such as simulation, statistics, numerical analysis, computer games, lotteries, cryptology, etc. In simulation, highly-uniform (or low-discrepancy) point sets can often advantageously replace the traditional random numbers. Their construction and analysis can be based on ideas and tools that are very similar to those used for random number generators and we want to strengthen this connection.

### Mathematical Models and Techniques for Analysing Systems

**September 30-October 4, 2002**
**Org. : Prakash Panangaden (McGill)**

Invited speakers: R. Alur, P. Caines, L. deAlfaro, R. Jagadeesan, D.Precup, R. Segala, F. van Breugel and M. Vardi.

The analysis of systems has both diversified and deepened tremendously in the last few years. In terms of diversification, systems of interest now include stochastic systems, real-time systems and hybrid systems, that is, systems where the state space is partly discrete and partly continuous. Applications include flight management systems for aircraft, process control systems, telecommunication systems and battle management systems. In all of these one has to deal with continuous time evolution and usually with probabilistic aspects as well. Perhaps the most successful mathematical technique for dealing with these problems - now almost 20 years old - is model checking. This is now being extended to probabilistic systems and the theory has advanced to the point where tools have been designed and built. In terms of the general mathematical theory co-inductive techniques, like bisimulation, have proved their value repeatedly.

The workshop would have two main speakers, who will each give five lectures: Prof. Marta Kwiatkowska, U. Birmingham "*Probabilistic Model Checking*" and Dr. Jan Rutten, CWI Amsterdam "*Coinductive Calculus*".

### Finite Model Theory

**March 2-9, 2003**
**Org.: Denis Thérien (McGill)**

This workshop will focus on the expressive power of logics and on the deep relationship between logic and computational complexity. The principal speaker will be Phokion Kolaitis (U.C. Santa Cruz). The workshop will be held at the Bellairs Research Institute of McGill University.

### Semigroups and Automata

**March 9-16, 2003**
**Org.: Denis Thérien (McGill)**

This workshop will discuss recent developments in the theory of automata and semigroups, in particular some dealing with long-standing open problems such as decidability of the dot-depth hierarchy and decidability of Rhodes complexity.

### Cryptographic reduction of quantum and classical protocols

**April 28 - May 2, 2003**
**Org.: Claude Crépeau (McGill)**

Invited speakers: D. Beaver, *C. Cachin, R. Cramer, C. Crépeau, I. Damgaard, P. Dumais, D. Gottesman, J. van de Graaf, *R. Impagliazzo, J. Kilian, D. Mayers, *M. Naor, *S. Rudich, L. Salvail, A. Smith, A. Tapp, S. Wolf, M. Yung.
*to be confirmed

Cryptographic protocols have been studied for two decades in the classical scenario under various computational assumptions. Such protocols as Bit Commitment, Oblivious Transfer and Multiparty Computations have been implemented and reduced to each other. Over the last few years, similar results are now achieved in the context of adversaries equipped with quantum computers. This workshop will bring together specialists of both classical and quantum cryptographic protocols who will present the state of the art in this fascinating area of research.

## Advances in Machine Learning

**June 2-13, 2003**
**Org.: Yoshua Bengio (Montréal), Balázs Kégl (Montréal), Doina Precup (McGill)**

Invited speakers: P. Bartlett, A. Barto, P. Frasconi, G. Hinton, M. Jordan, V. Koltchinskii, Y. Le Cun, M. Littman, G. Lugosi, S. Roweis, B. Scholkopf, D. Schuurmans, S Singh, R. Sutton.

Probabilities are at the core of recent advances in the theory and practice of machine learning algorithms. The workshop will focus on three broad areas where these advances are crucial: statistical learning theory, learning algorithms, and reinforcement learning. The workshop will therefore bring together experts from each of these three important domains. Among the sub - topics that will be covered, we note: variational methods, graphical models, the curse of dimensionality, empirical methods to take advantage of theories of generalization error, and some of the applications of these new methods.

## SEMINAR

There will be a year-long seminar on the mathematics of computing.

## COURSES

The Montreal universities offer a variety of courses in the area of the year. The list can be consulted at :
http://www.iro.umontreal.ca/cours/
http://www.cs.mcgill.ca/acadpages/grad/course-grad.html
http://www.cs.concordia.ca/programs/grad/courses.html
http://www.info.uqam.ca/dinfo/coursdepframe.html

# General Programme 2002-2003

## Joint IMA-CRM Workshop on Computational Methods for Large Scale Integer Programs

**October 14-19, 2002, Minnesota**
**Org.: William Cook (Rice University), Martin W.P. Savelsbergh (Georgia Institute of Technology), George Nemhauser (Georgia Institute of Technology)**

In the past decade there have been significant theoretical and computational advances in the field of integer programming. As a result there has been a greatly increased use of integer programming software in industry. However, the need to solve even larger and more complex problems continues to grow. In this workshop, we will bring together experts in various areas of integer programming and its applications. Theoretical and methodological topics included in the workshop are approximation algorithms for large scale linear programs, stochastic integer programming, branch-and-cut and branch-and-price, algebraic and combinatorial methods, decomposition, constraint programming and parallel implementation. Application areas include supply chain design and management, telecommunications, manufacturing, transportation, scheduling, and finance. The workshop will be of interest to mathematicians and operations researchers working in discrete and combinatorial optimization, computational scientists working in parallel computing, search, and constraint programming. Goals of the workshop include building a research agenda for the next decade, defining new areas of application, and stimulating cooperation among the different disciplines that contribute to the field.

## Joint IMA-CRM Workshop on Distribution systems: location and vehicle routing

**December 2-6, 2002, Montréal**
**Org.: Michel Gendreau (CRT, Montréal) and Gilbert Laporte (CRT, HEC)**

Invited participants: G. Laporte, A. Corberan, J.J. Salazar, D. Vigo, M. Salomon, S. Nickel, T.Lowe, P. Hansen, O. Berman, G. Wesolowsky, J. Thisse, P. Marcotte, B. Gavish, M. Gendreau, M. Savelsbergh, J.Y. Potvin, A. Balakrishnan, M. O. Ball, B. Jaumard, M. Labbé, C. Colbourn, T. Crainic, T. Magnanti

The questions surrounding distribution systems are of prime economic importance. The scale of these systems is increasing at a fast rate because of the growth of international commerce and travel. The advent of e-commerce will only increase their scale, as well as change their nature; goods purchased over the internet must be delivered; also, they often get returned. Related to these questions is the rich field of network design problems, which arise in particular in transportation logistics and in telecommunications planning.

The theory of location is evolving, with questions such as competitive location or the location of non-punctual or structured objects being studied; in routing, the advent of better communication devices and increased computational power make real-time dynamic routing a possibility. These changes imply that new problems with different mathematical properties must be tackled and new algorithmic strategies devised.

This workshop will include a series of ten surveys, covering both the more traditional and the newer subject areas, with additional contributions by conference participants. Areas covered include routing; location; economic aspects, pricing, e-commerce; fleet management; telecommunications; network design.

## Quantum Control: Mathematical and Numerical Challenges

**October 7-11, 2002**
**Org.: André Bandrauk (Canada Research Chair, Chemistry, U. de Sherbrooke, FRSC),Michel Delfour (CRM and DMS, U. de Montreal, FRSC)**
**Sponsors: NSERC and CRM**

This workshop will concentrate on advanced numerical methods and new mathematical and control and optimization approaches and tools for the quantum control of matter at the molecular level using current advanced laser technology.

An entire new branch of science now known as "Coherent Control of Molecular Processes" following the pioneering work of theoretical chemists such as Paul Brumer (Toronto), Moshe Shapiro (Weizmann Institute), Stuart A. Rice (Chicago), and other international and Canadian distinguished scientists is steadily making an impact on the experimental and technological world.

This new field of research is dedicated to "using current state of the art laser technology to control and manipulate the quantum behaviour and motion of matter at the molecular level". The basis of this new science is the encoding and control of quantum information at the molecular level in order to control the time evolution of

molecular processes, such as guiding the final output of a reaction to a desired target. Most of the research in this area has been numerical and theoretical, involving multidimensional time-dependent Schroedinger equations, TDSE's. Coupling these molecular processes to the laser field equations, Maxwell's equations, results in coupled parabolic (TDES's) and hyperbolic (Maxwell) partial differential equations. There are outstanding problems, both numerical and mathematical, which this workshop will address by bringing together mathematicans, theoretical chemists and physicists working in the area of control and optimization of systems subject to quantum laws.

The workshop will involve 20-30 international experts in laser molecule interactions, optimization, theory and control of molecular dynamics. It will emphasize participation of graduate students in applied mathematics, theoretical chemistry and physics.

## Main themes:

### Molecular and Electron Control

**Theoretical: Andre D. Bandrauk (Sherbrooke), Paul Brumer (Toronto), Ronnie Kosloff (Hebrew University), Herschel Rabitz (Princeton).**

**Experimental: Hideo Mabuchi (Caltech), Philip Howard Bucksbaum (Michigan) .**

### Quantum Control - Mathematical Problems & Theories

**Org.: Roger Brockett (Harvard), Goong Chen (Texas A & M), Michel Delfour (Montréal), Claude Le Bris (CERMICS, ENPC, Paris), Roberto Triggiani (Virginia), Jean-Paul Zolesio (CNRS and INRIA, France), Enrique Zuazua (Complutense, Madrid, Spain).**

### Quantum Computing

**Org.: Daniel Liedar (Toronto), Serge Lacelle (Sherbrooke), MIvanov (NRC-Ottawa), Raymond Laflamme (Waterloo), Richard E. Cleve (Calgary)**

### Numerical Methods

**Org.: Robert Wyatt Texas), Tucker Carrington (Montréal), Michel Fortin (Laval), Anthony Peirce (UBC), Gene H. Golub (Stanford U), William Hager (Gainesville), Claude Le Bris (CERMICS, ENPC, Paris), G. Turinici (INRIA-Rocquencourt)**

# Theme Year 2003-2004: Geometric and Spectral Analysis

## Scientific Committee

E. Bierstone (Toronto), W. Craig (McMaster), F. Finster (MPI), P. Gauthier (Montreal), D. Jakobson (MCGill),V. Jaksic (McGill), N. Kamran (McGill), R. Melrose (MIT), P. Milman (Toronto), J. Toth (McGill).

## Overview

Analysis has traditionally stood at the center of gravity of much of the research activity in mathematics. In particular, the fields of geometric and spectral analysis have played a fundamental role in shaping the major themes of current research in differential geometry and mathematical physics, and they stand indeed at the core of several of the deepest and most spectacular advances in these fields. There is now, for example a much deeper understanding of the eigenvalues and eigenfunctions of manifolds than there was even five years ago.

The thematic year in geometric and spectral analysis will focus on a number of themes in which this interaction has been particularly fruitful. The year is organized around two interconnected themes: the first, whose different subthemes cover the whole year, is principally centered on various questions in spectral analysis; it comprises what is in essence two short programs, one on contact geometry and the other on analysis on singular space, and a more extended period on spectral analysis in mathematical physics and number theory. The two short programs have a particularly strong emphasis on developing new connections to other areas of mathematics. The second theme relates to the analysis of the Einstein equations, a subject on which there has been spectacular progress in recent years. It is concentrated in the fall of 2003.

These themes have been chosen so as to have a balance between the geometric and spectral components of the scientific program, and also with the objective of highlighting some of the most interesting current applications of analytic ideas to physics.

There will be a strong emphasis on training through the short courses which will precede the proposed workshops, as well as through the coordination of the graduate course offerings in analysis and geometry in the Montreal universities. In particular, a minimum of eight short courses is being planned in connection with the various workshops. Some of these short courses are listed in the detailed program given below.

## Aisenstadt Chair Lecture Series

There will be two chairholders for the year.

### SPECTRAL ANALYSIS

## Contact geometry and analysis

**July 2003**
**Org.: R. Melrose, D. Auroux**

In the vigorous development of contact geometry, which has taken place over the past 10 years or so, the notion of a tight (or conversely an overtwisted) contact structure has proved to be central, with many deep and important applications to three-dimensional topology. On the analytic side, the notion of the quantization of a contact manifold, that is the existence of a generalized Szegö projection, has come to play a central role in developments related to the algebra of pseudodifferential operators of Heisenberg type and related homological questions. Both endeavors are related to embedding, or fillability, questions which remain substantially open, especially in the three dimensional case. It seems likely that there are important relationships between these various notions and structures, with probable consequences on each *side* It is hoped that by bringing this group together they will be able to understand these relationships and their repercussions.

The format is one of informal lecture series over two weeks, on subjects such as Contact Floer homology and symplectic field theory, Approximate holomorphic geometry, Gauge theory and symplectic fillings, Heisenberg algebras, Toeplitz quantization, Powers of circle bundles.

## Analysis and Resolution of Singularities

**August 2003**
**Org.: E. Bierstone (Toronto), P. Milman (Toronto), D.H. Phong (Columbia)**

Effective methods in resolution of singularities are becoming central to a modern generation of problems from analysis and geometry - for example, spectral theory and Hodge theorem for algebraic varities, stability of oscillating integrals, existence of Kähler-Einstein metrics, sharp forms of Moser-Trudinger inequalities. The diversity of the problems and their very

different origins and aims have led to a lack of communication among researchers on these and related topics. This program, bringing together leading experts in resolution of singularities, complex differential geometry, and real analysis and partial differential equations, may have ground-breaking impact.

**Week 1.** ***Workshop on oscillatory integrals and critical integrability exponents***
Topics include degeneracy of holomorphic functions in several variables, Legendre distributions and multiplier ideal sheaves.

**Week 2**. ***Short courses***
Three short courses to be accessible to graduate students in analysis, given by the organizers or other participants.

- Effective methods in resolution of singularities – ideas involved in desingularization algorithms, concrete examples with a view to applications in analysis and geometry.
- Stability questions in real and complex analysis; for example, stable forms of the method of stationary phase, stability of critical integrability exponents, ascending chain conditions, stability problems for degenerate Fourier integral operators.
- Real and complex blow up, resolution of metrics, configuration spaces and Lie algebras of vector fields - leading to a description of harmonic forms and $L^2$ cohomology of various singular spaces.

**Week 3** ***Workshop on resolution of singularities, metrics and the Laplacian***

The Hodge theorem, describing the harmonic forms on a smooth algebraic variety and relating them to its cohomology, has had wide impact on differential and algebraic geometry, and differential analysis. In the more general case of a singular projective variety, a description of the harmonic forms remains largely open, although there are substantial conjectures. An approach through resolution of singularities depends on understanding the structure of the Fubini-Study metric lifted to a resolution. The workshop will bring together researchers in geometric, algebraic and analytic areas related to these questions.

## Spectral analysis in mathematical physics and number theory

**November 2003-May 2004**

### Integrable and near-integrable Hamiltonian PDEs.

**November 2003**
**Org.: W. Craig (McMaster), P. Deift (Pennsylvania), H. Flaschka (Arizona), S. Kuskin (Heriot-Watt), P. Olver(Minnesota), P. Winternitz (CRM)**

This workshop will provide a cross-section of the most significant current activity in the field of Hamiltonian pdes, including integrability, asymptotics in the small dispersion limit, KAM theory, and Arnol'd stability. This workshop is organized in conjunction with the special year in analysis at the Fields Institute.

### Spectral theory of Schrödinger operators

**January 2004**
**Org.: V. Jaksic (McGill), Y. Last (Hebrew)**

The spectral theory of Schrödinger operators has been the stage of spectacular developments over the last ten years. The emphasis has shifted to the problems involving semiclassical limits and limits of large numbers of particles (e.g. atomic Hamiltonians) and to the problems involving quasi-peridic and random structures. The goal of the workshop is to bring together the world leading experts, young researchers and the graduate students in this fast developing field. The state of the art research and results will be described in an accessible way, and the new directions of research will be pointed out.

Short course lecturers: Barry Simon (Caltech), Bernard Helffer (Paris), Jan Phillip Solovaj (Copenhagen), Christian Gerard (Paris), Stanislav Molchanov (North Carolina), Wilhelm Schlag (Caltech)

### Dynamics in statistical mechanics

**February 2004**
**Org.: V. Jaksic (McGill), C.-A. Pillet (Toulon)**

The past ten years have witnessed some major new developments in the field of non-equilibrium statistical mechanics, owing to an influx of fresh ideas from probability theory and C*-algebras. This progress is complemented by the study of concrete, physically relevent models of infinite particle systems, for which the zeroth and the second law have been now rigorously established. The goal of the workshop is to bring together the world's leading experts in the field.

Short course lecturers: Jurg Frohlich (ETH), David Ruelle (IHES), Kuksin (Edinborough), Jan Derezinski (Warsaw), Jean-Piere Eckmann (Geneva), Varadhan (Courant)

### Toeplitz operators, Riemann-Hilbert problems and random matrices.

**March 2004**
**Org.: D. Jakobson (McGill), J. Toth (McGill).**

In the last decade, a number of deep connections have been established between random matrix theory, orthogonal polynomials, integrable systems of pdes of the Painleve and KP types, the Riemann-Hilbert problem, combinatorics, representation theory and statistical mechanics. By considering Toeplitz matrices, one can study eigenvalue statistics for quantizations of very general Hamiltonian systems on Kähler manifolds. This workshop will provide a unique opportunity for bringing together a number of key contributors to these developments.

Short course lecturers: A. Its (Indiana), K. McLaughlin (North Carolina)

### Semi-classical theory of eigenfunctions and pdes

**April 2004, (to be held at the fields Institute)**
**Org.: D. Jakobson (McGill), J. Toth (McGill)**

Many questions in quantum chaos are motivated by the correspondence principle in quantum mechanics. These include asymptotic bounds for the eigenfunctions, integrated and pointwise Weyl error terms, and scarring. Another fundamental question concerns the local and global statistical properties of the eigenfunctions, their nodal sets and critical points. These questions will from the main theme of the workshop.

Short course lecturers: V. Guillemin (MIT), N. Nadirashvili (Chicago)

### Spectral theory and automorphic forms

**Org.:Y. Petridis (CRM/McGill), J. Toth (McGill)**

Analytic questions about families of L-functions include the distribution of zeros and the generalized Riemann hypothesis, value distribution, special values as well as connections with arithmetical questions such as the distribution of primes, size of class gropups, analytic ranks and elliptic curves. This workshop will bring together some of the most active researchers in this rich and important area of mathematics, which lies at the boundary of analysis and number theory.

Short course lecturers: H. Iwaniec (Rutgers), A. Zaharescu (Illinois)

## ANALYSIS OF THE EINSTEIN EQUATIONS

**September-October 2003**

### Workshop on the Cauchy problem for the Einstein equations.

**September 2003**
**Org.: F. Finster, N. Kamran.**

A number of major advances have been achieved over the past few years in the analysis of the Cauchy problem in general relativity. These include the proof of the non-linear stability of Minkowski space, the proof of the Riemannian Penrose conjecture and the rigorous description of the asymptotic behavior at infinity of the admissible Cauchy data. This workshop will bring together some of the key players who have been involved in these developments, and will provide an opportunity for exploring some of the remaining open problems.

### Workshop on the interaction of gravity with external fields

**October 2003**
**Org.: F. Finster, N. Kamran.**

The interaction of gravity with external fields is governed by highly coupled systems of partial differential equations on manifolds. The analysis of these systems has lead to surprising results on the role of external fields in the dynamics of gravitational collapse and singularity formation. These results include, in the spherically symmetric case, the existence of stable particle-like solutions of the Einstein-Yang Mills equations, and the non-existence of black hole solutions when the gravitational field is coupled to a Dirac spinor field. One of the objectives of the workshop will be to review these developments, and to discuss some of the directions for future research.

Short courses: H. Friedrich (MPI), F. Finster (MPI), J. Smoller (Michigan)

# 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 benefits 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 W.T.Tutte of the University of Waterloo. 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 2000-2001:**

### Approximation, Complex Analysis and Potential Theory

**July 3-7, 2000**
**Université de Montréal, Montréal**
**Org.: A. Daigneault (Montréal), Norair Arakelian, (Institute of Mathematics, National Academy of Science of Armenia).**

**Supported by the National Program Committee (CRM, Fields, PIMS), Université de Montréal, NSERC and NATO**

There were a total of 68 participants.

This NATO Advanced Study Institute, which was the 39th Session of the Séminaire de mathématiques supérieures at the Université de

Montréal, focused on the interplay between complex analysis and potential theory.

The principal speakers were Alano Ancona, (Orsay) Norair Arakelian (Armenian Academy of Sciences), David H. Armitage (Queen's University of Belfast), Thomas Bagby (Indiana), Mario Bonk (Michigan), Huaihui Chen (Nanjing Normal University), David Drasin (Purdue), Stephen Gardiner (University College Dublin), Paul M. Gauthier (Université de Montréal) Thomas Ransford(Laval), Arne Stray (Bergen).

The proceedings of the conference, Approximation, Complex Analysis, and Potential Theory, will be published by Kluwer Academic Publishers.

## 12th Canadian Conference on Computational Geometry

**August 16-19, 2000**
**Fredericton, New Brunswick**
**Org.: David Bremner, (New Brunswick)**

**Supported by the National Program Committee (CRM, Fields, PIMS) and the University of New Brunswick, and sponsored by AARMS**

Computational Geometry is concerned with algorithms, software, and mathematical foundations for the treatment of geometric data by computer The Canadian Conference on Computational Geometry (CCCG) reflects this diversity of interest, with invited speakers and contributed papers on topics ranging from geometric applications in industry to the frontiers of pure mathematics. There were 75 participants at the conference from 1 0 countries. The plenary speakers were Gil Kalai, (Paul Erdos Memorial Lecture), Jerusalem; Naoki Katoh, Kyoto; and Colin Ware, New Hampshire.

A special issue of Computational Geometry: Theory and Applications devoted to papers from this conference will appear in October 2001.

## First Prairie Industrial Problem Solving Workshop

**August 7-11, 2000**
**Brandon, Manitoba**
**Org.: Lynn Batten (Deakin), John Brewster (Manitoba), Doug Pickering, (Brandon) & Michael Tsatsomeros (Regina).**

**Supported by the National Program Committee (CRM, Fields, PIMS), Brandon University, the University of Manitoba, University of Regina, the Institute of Industrial Mathematical Sciences and Western Economic Diversification Canada**

The First Prairie Mathematics and Industry Problem Solving Workshop attracted 45 faculty, students and industry representatives, predominantly from the provinces of Manitoba and Saskatchewan.

The participants developed solutions to three problems that were brought to the meeting by representatives of industry and government: Dr Norman Corbett, Department of National Defence (in Winnipeg), Dr. Darryl Dormuth, Atomic Energy of Canada Limited (in Pinawa), and Dr. Graeme Strathdee, Potash Corporation of Saskatchewen (in Saskatoon). This was followed by three days of intensive work by the participants. The problem sessions were assisted by three experts: Bob Blakely of Texas A & M University facilitated the AECL problem, Chris Budd of the University of Bath facilitated the DND problem, and Tim Myers of Cranfield University facilitated the Potash Corporation problem. Each working group presented a summary and recommendations of their work to the full group. These summaries are currently being written into reports which will be published in a proceedings volume in the near future, in both English and French. The reports will also be available on the web at www.math.brandonu.ca/workshopmath.

## APICS-AARMS: October 2000

Atlantic Association for Research in the Mathematical Sciences (AARMS) and Atlantic Provinces Council on the Sciences (APICS)
Annual Meeting

**October 20-22, 2000**
**Dalhousie University, Halifax**
**Org.: A. Coley, S. Ruan & R. Wood, Dalhousie University**

**Supported by the National Program Committee (CRM, Fields, PIMS), CMS / CMS Students Committee, Dalhousie University, Nelson Canada, Pearson Education Canada, John Wiley & Sons, McGraw-Hill Ryerson, MathResources Inc., Waterloo Maple, Inc.**

There were 3 plenary lectures, by Joachim Lambek (Blundon Lecture), McGill; Morven Gentleman, Dalhousie; and Larry Bretthorst, Washington University, St. Louis.

The annual Undergraduate Mathematics Competition was held on Friday, with a team of two students from each university member of APICS. And special student sessions were held, in which students presented the results of their honor theses or summer projects.

A special APICS session on Applied Mathematics & Numerical Analysis was held on Saturday, with the goal of bringing together researchers from Atlantic Canada to communicate their research work and encourage possible collaboration.

Two AARMS special research sessions were held on Sunday, in category theory and Bayesian statistics.

## CMS Winter Meeting

**December 10-1 2, 2000**
**Vancouver, Vancouver, B.C.**

**Supported by the National Program Committee (CRM, Fields, PIMS), the University of British Columbia, Simon Fraser University, The Vancouver Institute, the University of Calgary, The Centre for Experimental and Constructive Mathematics (CECM MITACS, University of Saskatchewan, University of Alberta, The Royal Society of**

**Canada Meeting Director: Dale Rolfsen, UBC**

**Local Arrangements Co-Chairs: Afton Cayford and John Fournier, UBC**

The meeting was attended by 286 participants.
The plenary speakers were Patrick Dehornoy (Caen), Richard Durrett (Cornell), Roger Howe (Yale), Izabella Laba (UBC), Stanley Pliska (UI Chicago) Paul Roberts (Utah), Peter Sarnak (Princeton). The Coxeter-James Lecture was given by Damien Roy (Ottawa), the CMS Doctoral Prize lecture by Stephen Astels (Georgia). Bernard Couteau, Sherbrooke was presented with the Adrien-Pouliot Award and Arthur Sherk (Toronto) received the CMS Distinguished Service Award.

There were special sessions in Algebraic Geometry, Classical and Computational Analysis, Financial Mathematics, History of Mathematics, Mathematical Education, Number Theory, Operator Algebras, Ordered Groups, Partial Differential Equations, and Probability and its Applications.

## Canadian Annual Symposium on Operator Algebras

**April 26-May 2, 2001**
**Mathematical Sciences Research Institute (MSRI) (Berkeley)**

**Supported by the National Program Committee (CRM, Fields, PIMS)**

**Co-Chairs: G. Elliott, University of Toronto and I. F. Putnam, University of Victoria**

This meeting was joint for the first two days with the MSRI workshop on Quantization and Noncommutative Geometry, and during the three-day period April 29 - May 1 it functioned as a closing conference for the 2000-01 MSRI program on Operator Algebras.

## Black Holes III: Theory and Mathematical Aspects

**May 19-23, 2001**
**Kananaskis inn and Conference Center, Kananaskis, Alberta**
**Org.: V Frolov (Alberta)**
**Supported by the National Program Committee (CRM, Fields, PIMS), The Canadian Institute for Advanced Research (CIAR), The Canadian Institute for Theoretical Astrophysics (CITA) and the University of Alberta**

Black Holes III was a research-related conference focusing on the latest advances in the theoretical and mathematical aspects of black hole physics. It paid special attention to such mathematically oriented problems as the string and M theory approach to black holes, numerical studies of black hole collisions and critical gravitational collapse, and exact solutions of Einstein's equations in higher and lower dimensions.

## Groups, Rings, Lie and Hopf Algebras

**May 28-June 1, 2001**
**Memorial University**
**Org.:Y. Bahturin, E. Goodaire, M. Parmenter & Y Zhou (Memorial Univ.)**

**Supported by the National Program Committee (CRM, Fields, PIMS), and the Memorial University of Newfoundland**

Yuri Bahturin, with help from Edgar Goodaire, Michael Parmenter and Yiqiang Zhou of Memorial University, ran a highly successful International Workshop on Groups, Rings, Lie and Hopf Algebras, sponsored by AARMS (the Atlantic Association for Research in the Mathematical Sciences) and Memorial's Department of Mathematics and Statistics. The workshop attracted 40 researchers from 10 countries, from Russia to Japan and Belgium to Brazil. Professor Susan Montgomery of the University of Southern California was named the first AARMS *Distinguished Lecturer*, and gave two talks on *Finite-dimensional Semisimple Hopf algebras*.

In addition to a plenary talk, *Lie algebras over rings of differential operators*, Fields medalist Efim Zelmanov delivered a well-attended public address entitled *Abstract Algebra in the 20th Century*, on the first evening of the meeting.

More information and the schedule of the meeting may be found at
http://www.math.mun.ca/-yuri/GRLHA/default.htm

## CMS Summer Meeting

**June 2-4, 2001**
**University of Saskatchewan**
**Org.: C. Soteros, M. Bremner, Y. Cuttle & F.-V. Kuhlmann, (Saskatchewan)**
**Supported by the National Program Committee (CRM, Fields, PIMS), and the University of Saskatchewan**

**Meeting Director: K. Taylor, University of Saskatchewan**

The 2001 Summer Meeting of the Canadian Mathematical Society was both a scientific and organizational success. There are relatively few mathematicians who live within easy traveling distance of Saskatoon, so the total of 279 registered participants exceeded most expectations and seems to be a record for a regular summer meeting.

The CMS Jeffery-Williams Lecture was given by David Boyd, University of British Columbia, and the CMS Krieger-Nelson Lecture by Lisa Jeffrey, University of Toronto. The plenary lecturers were Georgia Benkart, Wisconson-Madison; Zoe Chatzidakis, Paris; Geoffrey Grimmett, Cambridge; and Barry Simon, Cal Tech.

There were also ten well-attended special sessions in Abstract Harmonic Analysis, Geometric Topology, Graph Theory, Infinite Dimensional Lie Theory and Representation Theory, Mathematical Education: Cognition in Mathematics, Matrix Analysis, Model Theoretic Algebra, Number Theory - in Honor of David Boyd, Rigorous Studies in the Statistical Mechanics of Lattice Models, and Scattering Theory and Integrable Systems.

## CAIMS

**June 7-9, 2001**
**University of Victoria, B.C.**
**Supported by the University of Victoria, PIMS, The Fields Institute, CRM, MITACS and the Laboratory for Automation Communications and Information Systems Research (University of Victoria)**

**Scientific Committee Chair: Florin Diacu, University of Victoria Local organizers: R. Edwards and D. Leeming, University of Victoria**

About 120 participants enjoyed 6 thematic sessions plus a poster session. The sessions were: Applied Dynamical Systems (plenary speaker, Jerrold Marsden), Data Compression (plenary speaker, Bin Yu), Fluid Dynamics (plenary speaker, Grae Worster), Computational Biology (plenary speaker, Tandy Warnow), Mathematical Biology (plenary speaker, Hal Smith), and Neural Networks and Neural Dynamics (plenary speaker, Nancy Kopell).

A panel of five judges evaluated the contributed presentations (both posters and short talks) by graduate students and postdoctoral fellows. First prize was awarded to Ricardo Carretero-Gonzalez of Simon Fraser University, with honorable mentions going to Gustavo Carrero of the University of Alberta, and Chee Tiong Ong.

## 29th Annual Meeting of the Statistical Society of Canada (SSC)

**June 10-14, 2001**
**Western North American Region of the International Biometric Society (WNAR) and the Institute for Mathematical Statistics (IMS) on the campus of Simon Fraser University (SFU) in Burnaby, B.C,**

**Supported by the National Program Committee (CRM, Fields, PIMS) and Simon Fraser University**

The meeting was a grand success with approximately 500 registered participants.

Four workshops were held:

- *Inferences from Genetic Data on Pedigrees* by E. Thompson, U. Washington;
- *The Analysis of Sample Survey Data* by J. Eltinge, U.S. Bureau of Labor Statistics and Texas A&M;
- *Data Mining* by H. Chipman, U. Waterloo;
- *Beyond MCMC: Monte Carlo Methods in Bayesian Computation*, by J. Ibrahim, Harvard School of Public Health and M. Chen, Worcester Polytechnic Institute.

There were 55 sessions in total ranging from sessions on Genetics and Forestry to Discrete Probability and Combinatorics, with a range of internationally known speakers and sessions aimed at graduate students.

The complete program is available on the web at http://www.math.sfu.ca/-tim/sscmtg.html.

## 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 main vehicle for the CRM's efforts in this area is the research networks to which it belongs. There are two of these, one the Network for Computing and Mathematical Modelling (nc$m_2$), involving seven research centres in the Montreal area in a multi-disciplinary consortium, and MITACS, a national network. In addition, it has concentrated its efforts in a few chosen areas in which it can develop a significant presence.

## NETWORK FOR COMPUTING AND MATHEMATICAL MODELLING (nc$m_2$)

The CRM serves as the organisational centre for the Network for Computing and Mathematical Modelling, nc$m_2$ (in French: Réseau de calcul et de modélisation mathématique, rc$m_2$), a collaboration which allows the network to respond to the needs of industry in a large number of fields related to a common area of computing and mathematical modelling, mostly around five major themes: (1) risk management, (2) information processing, imaging and parallel computing, and (3) transport and telecommunications, (4) health and (5) electronic commerce.

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).

### NSERC-funded research projects

The nc$m_2$ has completed the fourth year of a 5-year NSERC grant with an average of $600K per year.

The year 2000-2001 saw the consolidation of a set of projects started in 2000, and funded as part of two-year cycle, as well as the launch of a series of new projects. The network funded the following 9 projects during 2000-2001:

- *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 & **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 & **Brigitte Kerhervé**, UQAM
- *Approche hiérarchique et multi-échelles pour la localisation des sources d'activité en MEG/EEG.*
  **Bernard Goulard**, CRM

Overall, the projects have involved the participation of 55 researchers in the network centres, and 76 postdoctoral fellows and graduate students. The total value of the contributions of our partners in 2000-2001 was $737K cash and $423K in kind. The industrial partenaires involved at some point with nc$m_2$'s research projects are : AD OPTTechnologies Inc., ANIQ R&D Inc., Banque nationale du Canada, Centre de sécurité civile du Québec, CHUM (Centre hospitalier de l'Université de Montréal), CLSC Côte-des-Neiges, Consultants INRO Inc., Environnement Canada, Bombardier, Prévost Car Inc., ADS Groupe Composites Inc., Groupe Québec-Cartier, Hydro-Québec, HydroSoft, Bell Mobilité, Assurance AXA, HMS Énergie, Insurance Bureau of Canada, Microcell, Société de l'assurance automobile du Québec, Silicon

Graphics Inc., Insurance Company of British Columbia, Air Canada, Ultramar, Hôpital Royal Victoria, Lockheed Martin Electronic Systems Canada, Montreal Jewish General Hospital, Urgences Santé, Centre universitaire de santé McGill (MUHC), Société canadiennes des postes, Astra Zeneca, Boehringer-Ingelheim, Merck Frosst, Biochem-Pharma, CCG.

### ⋁ Network activities

The nc$m_2$ organises various networking activities. One popular item is its *Grandes Conférences* series, which had two lectures in 2000-2001:

*Designing Telecommunication Network: Modeling Issues, Mathematical Problems, and some Solutions*
**25 September 2000**
**Martin Grötschel,** (Konrad-Zuse-Zentrum für Informationstechnik und Technische Universität, Berlin.)

*Training products of experts by maximizing contrastive likelihood*
**23 October 2000**
**Geoffrey Hinton,** (Univ. College London)

In addition, there was a workshop whose purpose was to reinforce networking between the CRM and some French partners in brain imaging:

*Plasticité cérébrale et modélisation mathématique*
**5-6 March 2001**
**Bernard Goulard** (CRM, Univ. de Montréal) & Habib Benali (CHU Pitié-Salpêtrière & CRM)

## LABORATOIRES UNIVERSITAIRES BELL

The CRM is an active participant in the nc$m_2$'s Laboratoires universitaires Bell, part of a joint project between the nc$m_2$ 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 which is used to finance research projects, to endow chairs and to finance a research infrastructure. The laboratory has 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.

A dozen research projects were funded during 2000-2001. Of these, 5 were 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*.

## LABORATOIRE UNIVERSITAIRE SUR LE TEMPS EXTRÊME *(LUTE)*

The summer of 2001 saw the birth of a new nc$m_2$ laboratory, the Laboratoire Universitaire sur le Temps Extrême (LUTE). The laboratory involves a contribution of $300K per year from Environment Canada, a significant contribution ($1M) in computer time, as well as the presence in the university environment of a good number of Environment Canada's researchers. The laboratory will involve not only meteorological research but also an extensive study into impacts as well as mitigating measures.

## INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

The nc$m_2$ has arranged for an exchange program with the Institute for Mathematics and its Applications in Minnesota. This institute is the US's major research institute in Applied Mathematics. As part of the IMA's 2002 programme, the nc$m_2$ will be hosting a workshop on distribution networks in the fall of 2002. As well, the IMA will host a certain number of nc$m_2$ post-doctoral fellows during the year.

## 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. 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 the CRM-centred research projects are: Ad-Opt Technologies, Air Canada, Heart & Stroke Foundation, Hydro-Québec, Laboratoires Universitaires Bell, National Bank of Canada, and. Procter & Gamble.

The second general annual meeting of the network was held in May 2001 in Montreal. This large-scale event with over 200 participants 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. A panel selected the best poster presentations.

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 annual theme meetings where technical details of the research can be discussed more easily than in the general meeting. The CRM hosted the following two meetings :

- **Biomedical applications**
  **4-5 November 2000**
  Org.: Robert Muira, Univ. of British Columbia
- **Finance**
  **9-10 February 2001**
  Org. : René Garcia, Univ. de Montréal-CIRANO

Finally, each of the institutes has organized special events (workshops, seminars, conferences) linked to the MITACS projects. The following activities were organized by CRM:

**New Methods in Financial Risk Management**
**October 13, 2000**
Invited speakers: Frank Diebold (University of Pennsylvania and NBER), John Galbraith (McGill University and CIRANO), Victor Chernozhukov (MIT), Simone Manganelli (European Central Bank).

**Estimation of Diffusions**
**November 3, 2000**
Invited speakers: Yacine Ait-Sahalia (Princeton University), Ola Elerian (Nuffield College, Oxford University), Michael Johannes (Columbia University).

**Volatility Modeling and Financial Applications**
**December 1, 2000**
Invited speakers: Andrew Matytsin (Merrill Lynch), Eric Jacquier (Boston College University & CIRANO), Marc-André Lewis (CIRANO).

**New Approaches for Volatility Modeling**
**February 23, 2001**
Invited speakers: Robert Engle (Stern Business School, New York University), Neil Shephard (Nuffield College, Oxford University), Nour Meddahi (Université de Montréal, CRDE and CIRANO).

**Finance Day on Option Pricing**
**April 6, 2001**
Invited speakers: David Bates (University of Iowa), Jin-Chuan Duan (University of Toronto and Hong Kong University of Science & Technology), Stylianos Perrakis (Concordia University), Éric Renault (Université de Montréal, CRDE and CIRANO).

**May 4, 2001**
Invited speakers: Nikolay Gospodinov (Concordia), Silvia Gonçalves ((Université de Montréal), Gordon Fisher ((Concordia).

**Corporate Finance**
**May 11, 2001**
Invited speakers: Randall Morck (University of Alberta), Denis Gromb (MIT), Anup Agrawal (University of Alabama), Martin Boyer (HEC and CIRANO).

One of the highlights of the year was the "*First ever CRM-MITACS Spring School on Optimisation*". Montreal has a very strong school in optimisation, and it was natural to organise a school on the subject. The event was very well attended, with over one hundred participants. There were eight series of four lectures, given by:

- **John Dennis**, Rice
  *Pattern Search in Optimization*
- **Jacques Desrosiers**, HEC, Montréal
  *Column Generation*
- **Michel Gendreau**, Univ. de Montréal
  *Metaheuristics*
- **Pavol Hell**, Simon Fraser
  *Graph Partitioning*
- **Martine Labbé**, Univ. Libre de Bruxelles

*Design of Telecommunication Networks*

- **Maurice Queyranne**, Univ. of British Columbia *Submodular Optimization*
- **Stefan Scholtes**, Cambridge Univ. *Bilevel optimization*
- **Paul Tseng,** Univ. of Washington at Seattle *Semidefinite complementarity*
- **David Williamson**, IBM Almaden Research Center, *Approximation algorithms*

On the research side, among the projects linked to the CRM, let us note a few 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 classifying and detecting 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 modelling 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.

## IMAGING

The CRM has developed over the last few years a considerable expertise in the area of imaging, in particular brain imaging, with a particular emphasis on the area of the statistical analysis of images. This has lead to several important research links with laboratories working in the area of brain imaging, most notably McGill's, Brain Imaging Centre (BIC) and the laboratory of brain imaging at the Pitié-Salpétrière in Paris. The CRM has participate in two large inter-institutional initiatives to obtain imaging and computing equipment: the first as part of the MCBIR consortium centred at the BIC, which was awarded 23M by the Canadian Foundation for Innovation (CFI), and another as part of a University of Montreal-based consortium, which is still under adjudication. In parallel, it was the lead institution in setting up a Valorisation Recherche Québec proposal called Mathématiques et Technologie de l'Imagerie Cérébrale (MITIC), which if successful, will equip the community with some of the research personnel to run all the large machines. The proposal is still under adjudication.

# 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.**

***André Bandrauk*** professor in the chemistry department, Université de Sherbrooke and on sabbatical leave at CRM in 2000-2001 has been awarded the prestigious 2001 John-Polanyi prize. The award ceremony took place during the 84th conference of the Canadian chemical society in Montréal, March 2001. This prize was created in honour of John C. Polanyi, recipient of the 1986 Nobel Prize in chemistry

***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. He also received a Canada Research Chair in Mathematics for the years 2000 through 2006 (CRC).

***Francis Clarke*** was appointed a senior member of the Institut universitaire de France (September 2001)

***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

***Bernard Goulard*** of Université de Montréal took part in the Radio-Canada television show *Découvertes* on quantum mechanics on 5/11/2000. He was also a participant in the radio news of Nouvelles Radio-Canada, RDI, on the Kursk submarine tragedy, 18/08/2000.

***Michel Grundland,*** of Université du Québec à Trois-Rivières was awarded for the Alan Richards Fellowship at the University Durham.

***Niky Kamran*** of McGill University was the principal lecturer of a series of ten CBMS-NSF Lectures in Pure Mathematics, Washington D.C., 2000.

***François Lalonde*** of Université de Montréal was awarded a Canada Research Chair in differential geometry and topology.

***Robert Langlands*** received on November 27 2000, the *Grande Médaille d'or de l'Académie des sciences* (2000) from the Institut de France.

***Jean LeTourneux*** took part in a Université de Montréal round-table on culture and the university: mission impossible? He was also a participant in the television show *Découvertes* on quantum mechanics and its beginnings, in December 2000 on SRC.

***John McKay*** of Concordia University was named a Fellow of the Royal Society of Canada 2000. He also received the Faculty Award of Excellence 2001

***Christiane Rousseau*** has been appointed to become the president-elect of the Canadian Mathematics Society, starting June 1, 2001. In June 2002, she will then become its President for a two-year term.

***Ronald Stern*** of Concordia University was awarded the Ulam Chair at the University of Colorado at Boulder for the academic year 2000-2001.

***Keith Worsley*** of McGill University gave the Statistical Society of Canada Presidential Invited Address at the Joint Meetings of the Statistical Society of Canada, the Western North American Region of the International Biometric Society and the Institute of Mathematical Statistics in Vancouver last June. Entitled *The Geometry of Random Images in Astrophysics and Brain Mapping*, it surveyed his pathbreaking work in applying sophisticated statistical and probabilistic tools to the study of brain mapping and astrophysical images.

# 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.

### *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 d'occupation, de la restauration de l'équipe à la fin des années quarante et de son institutionnalisation dans les années cinquante. 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 des mathématiques qui étaient en train de se développer, notamment en théorie des ensembles, en algèbre, en analyse et en théorie de l'intégration. Ce travail d'historien s'appuie sur une abondante documentation inédite (écrite, orale et photographique) dont une partie fera l'objet d'une publication sous la forme d'une base de données, portée sur CD-ROM. Le chercheur a aussi mis sur pied un atelier consacré à l'histoire de la théorie des catégories ; une première rencontre, organisée en collaboration avec Michael Barr (McGill) a eu lieu au CRM en août 2000 ; la deuxième rencontre, organisée en collaboration avec Luc Belair (UQAM), aura lieu au CRM en septembre 2001.

### *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 le feedback non linéaire à retard en contrôle, dans les systèmes d'oscillations hormonales et neuromusculaires, en insistant sur le rôle du délai, des boucles multiples de feedback et des délais variables dans la génération de comportements périodiques (oscillatoires) ou irréguliers.

En collaboration avec J. Mahaffy, M. Mackey et M. Santillan, on a 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. Avec M. Mackey, ce travail est intégré dans le développement d'un modèle général d'hématopièse pour identifier l'origine physiologique des oscillations dans la neutropénie.

Une 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, et aboutissant à la mise au point d'un modèle original. Une autre collaboration vise à développer un modèle basé sur des principes physico-chimiques pour expliquer les profils observés dans l'administration de médicaments à l'aide de microsphères.

Enfin, un étudiant a travaillé dans le cadre du réseau MITACS, 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.

### *Nantel Bergeron*
**Structure combinatoire et algébrique**

Nous nous intéressons à l'étude de structures algébriques en utilisant la combinatoire. De 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.
L'étude des fonctions quasi-symétriques et symétriques non-commutatives.

En ce qui concerne (a), 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 (b), 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.

Pour (C), nous lions (A) et (B) par une étude exhaustive de ces fonctions.

### *Steven Boyer*
**Studies in Low-dimensional Topology**

His research efforts 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 involved the 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 and Zhang have collaborated with Cameron Gordon to study Dehn fillings of large hyperbolic 3-manifolds and with Marc Culler and Peter Shalen to investigate new applications of the Jaco-Shalen-Johannson theory of characteristic sub-manifolds. Also he began a collaboration with Dale Rolfsen (UBC) and Bert Wiest (Rennes) centered 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.

### *Robert Brunet*
**Applications des mathématiques au domaine biomédical**

Mes recherches actuelles portent sur les domaines suivants :

- les risques toxicologiques chez l'humain dus à la présence de matières toxiques dans l'environnement
- l'épidémiologie théorique.

En toxicologie, je collabore depuis 7 ans avec le Dr Gaétan Carrier de la Faculté de Médecine. L'approche que nous avons développée fait intervenir des systèmes d'équations différentielles (linéaires et non-linéaires) et des outils statistiques pour modéliser l'absorption, la distribution, la métabolisation et l'élimination de substances toxiques absorbées par les humains et les animaux. Chaque substance porte ses propres mécanismes biologiques et physiques qui doivent être incorporer dans un modèle spécifique. Nos travaux publiés jusqu'ici touchent les intoxications par les dioxines/furannes, le pyrène, l'azimphosméthyl (un insecticide), le méthyl-mercure absorbé par la consommation d'aliments, le méthanol et le formaldéhyde présents en milieu industriel.

En épidémiologie théorique, mes recherches se poursuivent en collaboration avec le Dr Claudio Struchiner de la Fundaçao Oswaldo Cruz au Brésil. Elles visent la reconstruction, à partir de données épidémiologiques accessibles, de variables qui ne sont pas accessibles directement mais qui sont toutefois importantes pour prédire le développement des maladies infectieuses. Les principales mathématiques utilisées sont les systèmes d'équations aux dérivées partielles et des méthodes de régularisation statistique.

### *Francis Clarke*
**Stabilisation d'un système contrôle par retour d'état**

Depuis quelques années, les recherches de Francis Clarke portent surtout sur la théorie du contrôle. Les points forts récents sont les suivants:

- Nouvelle approche aux fonctions Lyapounov pour la stabilité.

- Méthode originale de construction de retour d'état optimal en théorie de la commande.
- Résolution d'un problème classique en contrôle, en montrant qu'un système est commandable vers l'origine si et seulement si l'on peut le stabiliser par un retour d'état (feedback.)
- Élaboration d'un nouveau concept de retour d'état éventuellement discontinu; étude de robustesse.

### *Henri Darmon*
**Complex Multiplication for real quadratic fields**

Last year I was led me to introduce the notion of modular forms of weight (2,2) on the product of a p-adic and Poincare upper half-plane and to define p-adic periods associated to such forms. This clarifies the relation between the exceptional zero conjectures of Mazur, Tate and Teitelbaum and my study with Bertolini of the anticyclotomic case. Most significantly perhaps, this provides a conjectural p-adic analytic construction of global points on elliptic curves, points which are defined over ring class fields of certain real quadratic fields. This is intriguing, insofar as it suggests that the theory of complex multiplication should extend (at least conjecturally) to real quadratic fields. It is still an open question (known as Hilbert's 12th problem, or Kronecker's Jugendtraum) to supply analytic constructions of the class fields of real quadratic fields (or of more general number fields) along the lines of what is accomplished by the theory of complex multiplication for imaginary quadratic fields.

### *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).

### *Daniel Dufresne*
**Stochastic Processes in Finance**

The project concerns the Mathematics of Finance. The pricing of financial derivatives is based on no-arbitrage arguments, in a partial equilibrium model of the economy. The model is expressed in probabilistic terms. In many cases, prices are shown to be expected values. The computation of those expected values requires various mathematical tools: stochastic processes, series expansions, partial differential equations, and so on. In particular, the project deals with the distribution of functionals of Brownian motion.

### *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**

Ma recherche s'oriente sur deux axes de la bioinformatique. Le premier concerne la recherche de structures d'ARN dans les séquences génomiques. Étant donné une famille particulière de motifs biologiques structurés (motifs d'ARN de transfert, d'ARN ribosomiques, d'introns auto-catalytiques...), le problème général est de localiser dans le génome tous les motifs qui sont susceptibles d'appartenir à une telle famille. Les motifs sont définis par un certain nombre de contraintes liées à leurs structures primaire (1D), secondaire (2D) (hélices, triple-hélices, pseudo-noeuds) et même tertiaire. Alors que plusieurs méthodes efficaces existent pour la recherche de séquences, il n'existe aucune méthode efficace pour la recherche de structures secondaires conservées. Nous avons développé un algorithme de recherche très flexible et relativement rapide pour la recherche de toutes sortes d'hélices. Notre objectif est d'améliorer cet algorithme du point de vue de sa complexité en temps, mais aussi de la souplesse de la représentation d'une structure secondaire. Notre but est également de transformer le prototype en un logiciel professionnel facile à utiliser, comportant une interface graphique appropriée et un moyen interactif d'agir sur la représentation des hélices.

Mon deuxième axe de recherche concerne la comparaison de génomes, dans le but d'inférer des relations d'évolution entre les espèces. L'approche génomique consiste à comparer l'ordre des gènes dans deux génomes différents. Le domaine lié aux réarrangements de gènes date du début des années 90, et son champs d'utilisation devient de plus en plus important. En effet, une multitude de génomes sont maintenant complètement séquencés, et il devient possible d'inférer des relations d'évolution à partir de la totalité du matériel génétique des espèces. 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 variés et complexes. Nous avons contribué à différents aspects de ces problèmes. En particulier, nous avons développé un outil qui permet de rechercher le scénario d'évolution le plus parcimonieux entre deux espèces, en considérant des inversions pondérées.

### *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.

### *Marlène Frigon*

**Théorie des points critiques pour des fonctionnelles multivoques**

Les recherches de Marlène Frigon portent principalement sur l'existence de solutions aux équations et inclusions différentielles avec ou sans impulsions. Les méthodes utilisées sont topologiques et variationnelles. Dans ce dernier domaine, elle a apporté une contribution originale sur l'application de ces méthodes aux équations aux dérivées partielles et elle a contribué directement au développement de la théorie des points critiques en élaborant quelques aspects d'une théorie des points critiques pour des fonctionnelles multivoques.

Les recherches de Marlène Frigon portent également sur la théorie des points fixes. Elle a récemment généralisé à des systèmes infinis des résultats classiques en théorie des équations différentielles à savoir les théorèmes de Picard et de Peano. Aussi, comme mentionné précédemment, ses travaux portent sur les équations différentielles avec impulsions. Ces problèmes sont particulièrement difficiles lorsque les impulsions se produisent à des moments variables. Avec D. O'Regan, elle a obtenu plusieurs résultats dans ce domaine.

### *Langis Gagnon*

**Traitement et analyse d'images haute résolution**

Les travaux du Dr Langis Gagnon, membre associé au CRM et responsable de l'équipe Vision et Imagerie du Centre de Recherche Informatique de Montréal (CRIM), portent, entre autres, sur le traitement et l'analyse de scènes terrestres dans les images satellites haute résolution (optiques, multi-spectrales et radars.) Les thèmes étudiés incluent le filtrage multirésolution du chatoiement dans les images RADARSAT, la caractérisation texturale des images IKONOS pour des fins de segmentation des boisés, le raffinement de résolution des images multispectrales, la segmentation des zones hydriques dans l'imagerie radar par contours actifs géométriques, la détection de réseau routier, etc. Ces travaux sont subventionnés par le CRSNG et le CRIM avec une contribution en bourses d'études du CRM. Un autre domaine principal de recherche porte sur l'analyse des images ophtalmiques et est supporté en partie par une subvention d'infrastructure du FCI. Tous les étudiants supervisés par le Dr Gagnon bénéficient d'une bourse du programme de bourse d'études supérieures en milieu de pratique du fond FCAR.

### *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 are lagging behind. This is my current main area of research.

### *Paul Gauthier*

**Analyse**

Gauthier et ses collaborateurs et étudiants continuent leurs recherches en approximation et ont amorcé une étude des rapports avec le problème principal des mathématiques pures – celui de trouver les zéros de la fonction zeta de Riemann.

### *Pawal Gora*

**Absolutely continuous invariant measures in one and higher dimensions.**

The theory of one and higher dimensional piecewise expanding transformations is a beautiful, important and challenging subject for research. Methods ranging from theory of numbers and elementary geometry to measure theory and functional analysis are used. In turn these transformations find application in many physical and biological problems.

A very useful in applications generalization is so called "random map", a process that on each step applies a map from some family according to a given set of probabilities. One of the applications is a model of the superposition of quantum states in alternative (based on theory of fractal space-time) approach to quantum physics.

We want to continue our study of one and higher dimensional maps and random maps, and explore the properties of their invariant measures. Another problem is the global control of higher dimensional systems using methods related to acims. One and two-dimensional results are very promising. Still another field we plan to explore are applications of dynamical systems to biology and medicine. We have some results in this direction and will continue our work. In particular, in collaboration with medical specialists, we will work on the dynamics of 6-MP metabolism when the drug is

used in the Inflammatory Bowel Disease treatment.

### *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.) Les premiers résultats ont été présentés.

Par ailleurs, dans un projet subventionné par Bell-Lub, B.Goulard, J.M.Lina et F. Nekka travaillent en collaboration avec B. Johnston (INRS Telecom) 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. Un premier prototype de serveur a été mis en œuvre et testé avec des images de fond de l'œil et des opérateurs très simples.

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

### *John Harnad*

**Systèmes intégrables, déformations isomonodromiques et applications**

Pendant l'année passée (2000-20001), les projets suivants ont été développés:

La relation entre deux approches aux systèmes hamiltoniens complètement intégrables a été mise au point : l'une est fondée sur les flots hamiltoniens isospectraux dans les groupes et les algèbres de lacets, générées par les invariants spectraux avec une structure de Poisson qui provient d'une matrice R classique; l'autre, l'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 (c'est à dire : l'existence des structures multihamiltoniennes, les invariants commutatifs provenant du théorème de Gel'fand-Zakharevich et les coordonnées séparatrices associées aux vecteurs propres du tenseur de Nijenhuis) découlent de la théorie des matrices R associées aux structures de Poisson holomorphe sur les surfaces complexes. Cette approche a été étendue également aux cas des structures de matrices R classiques quadratiques, et aux cas trigonométriques et elliptiques.

Un nouveau projet, développé conjointement avec Marco Bertola et Bertrand Eynard, concerne les modèles multi-matriciels aléatoires et les polynômes bi-orthogonaux. Nous avons démontré que les systèmes d'équations de récurrences satisfont par les polynômes biorthogonaux par rapport aux mesures de la forme d'exponentielles d'un polynôme, les systèmes différentiels et les systèmes de déformations induites par des changements dans la mesure sont compatible, et ainsi la monodromie des systèmes différentiels est invariante par rapport aux déformations. Une généralisation du théorème classique de Christoffel-Darboux sur les sommes des polynômes orthogonaux a été déduite pour le cas biorthogonal. Nous avons également démontré un théorème de « dualité » spectrale qui dit que les courbes spectrales associées aux couples duaux de systèmes d'équations différentiels sont égales.

### *Jacques Hurtubise*
**Systèmes intégrables**

Les travaux de J. Hurtubise ont porté sur les systèmes intégrables. Deux articles, un sur les systèmes de Hitchin, et l'autre sur les modules de fibrés paraboliques sont parus. Un autre, portant sur la séparation de variables pour les systèmes de Sklyanin a été soumis. Cet article a donné lieu à un projet majeur sur la généralisation de ces systèmes à des groupes réductifs arbitraires présentement en voie avec E. Markman.

### *Dmitry Jakobson*
**Semiclassical Asymptotics in Spectral Geometry**

The main interests of this researcher lie in the area of analysis, especially the properties of eigenvalues and eigenfunctions of Laplace operators on Riemannian manifolds. The correspondence principle in quantum mechanics predicts that in the high-energy limit. Those properties would depend on the geodesic flow on the manifold, and this researcher is involved in a detailed study of this correspondence, other areas of interest include the study of Lp norms of eigenfunctions, their nodal sets and critical points.

Another project concerns the study the statistics of zeroes of generalized lame harmonics in various regimes (semiclassical, thermodynamic etc.) and their complex analogues.

This researcher is also studying the spectra of elements of group rings and certain questions in extremal & spectral graph theory.

### *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 (en collaboration avec P. Olver et T. Robart) 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. Ces travaux sont réalisés en collaboration avec F. Finster, J. Smoller et S. T. Yau.

### *Paul Koosis*
**Amélioration de l'estimation harmonique**

Jusqu'à récemment l'estimation harmonique (c'est-à-dire 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.

### *Dimitry Korotkin*
**Riemann-Hilbert problems and tau-functions in integrable gravity models**

During the 2000-2001 year the research went in the following main directions. First, it was analysis of a class of matrix Riemann-Hilbert problems solvable via the objects associated to compact Riemann surfaces.
Riemann-Hilbert problems of that kind arise in relationship with conformal field theory, as well as in the theory of exact solutions of Einstein's equations. The main result in this direction was the solution of arbitrary Riemann-Hilbert problem with quasi-permutation monodromy matrices in terms of Szego kernel on an auxiliary Riemann surface. It was established explicit link between Malgrange divisor of the Riemann-Hilbert problem and theta-divisor on the Jacobian of the auxiliary algebraic curve.
Another problem was the application of algebro-geometric solutions of Einstein's equations (found by the author 12 years ago) to realistic physical systems, in particular to rotating dust discs interacting with central black hole.
Some preliminary results were obtained in this direction; in particular, the stationary axially symmetric Einstein's equations were derived from Fay's trisecant identity.

### *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, Aspinwall, 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 fibrations symplectiques ou algébriques, à partir de méthodes tout à fait nouvelles. Je poursuis également l'étude des groupes de difféomorphismes symplectiques de certaines variétés rationnelles qui conduit à une connaissance du type d'homotopie rationnelle de l'espace des plongements symplectiques de la boule standard.

### *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.

### *Frédéric Lesage*
**Détection automatique des micro événements dans les EEG du sommeil**

Les domaines multi-disciplinaires sont devenus part intégrante de l'activité de recherche en mathématique. Parmi celles-ci, l'utilisation de techniques mathématiques modernes pour l'analyse d'images médicales et la reconnaissance de formes.

Le présent projet, fait en collaboration avec le centre du sommeil de l'hôpital Sacré-Coeur, consiste à étudier le problème des EEG du sommeil. Ces signaux sont à la base de l'analyse du sommeil et sont pris à partir d'électrodes positionnées sur le cerveau lors du sommeil. L'analyse elle-même se fait en interprétant les signaux enregistrés pour toute une nuit à partir de critères bien établis permettant de spécifier les différents stades du sommeil de même que certains événements ponctuels.

Un des problèmes rencontrés lors de ces analyses est le temps pris par un humain pour analyser une nuit de sommeil. Ici, des méthodes mathématiques d'analyse du signal cherchent à reproduire ce travail de façon automatique et reconnaître la présence de micro-événements dans les signaux EEG. À plus long terme, ces méthodes pourraient ouvrir la porte à une nouvelle forme d'analyse où des marqueurs mathématiques cachés, invisibles à l'analyste humain, seraient découverts.

Le projet est au tout début de son cycle de maturité et des algorithmes de détection de micro événements sont présentement étudiés. L'étape suivante sera la validation de ces algorithmes en utilisant plusieurs nuits de sommeil.

### *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**

L'activité scientifique de JM Lina est principalement consacrée à la modélisation statistique de certains processus reliés à l'imagerie médicale à des fins d'aide au diagnostic ou de compréhension au niveau fonctionnel. On s'intéresse ici aux situations où ces processus ne sont pas directement mesurés ou observés: associés ou non à une représentation particulière du signal, ils sont "cachés". L'objectif de cette modélisation est d'expliquer, de façon quantitative, les observations via le comportement de ces variables. Ce cadre méthodologique correspond aux approches Markoviennes en imagerie qui sont de plus en plus utilisées en traitement de l'information. On s'interesse à deux aspects mathématiques. D'une part, la représentation

des observations qui permet d'exhiber des propriétés ou des comportements typiques dans les données. Dans ce volet, la représentation hiérarchique (comme celle fournie par la représentation multi-échelle en ondelettes) est principalement étudiée. D'autre part, la modélisation statistique qui fait intervenir des variables explicatives à partir desquelles on peut répondre au problème posé. Ces deux sujets sont étudiés dans deux domaines de l'imagerie médicale. En mammographie, il s'agit de déterminer la présence de régions cancéreuses en mesurant la « rugosité » locale de l'image, particulièrement autour des foyers de microcalcifications. L'étude et la modélisation statistique des coefficients en ondelettes pour ce type de données constituent le cœur de ce thème de recherche. En imagerie cérébrale, on s'intéresse à la MEG qui consiste à déterminer les sources d'activation cérébrale à partir des mesures de magnéto-encéphalographie. La variable d'activation n'étant pas directement mesurée, nous étudions un modèle statistique de type *Markov caché*. Finalement, modélisation multi-échelle et inférence statistique en résolution de problèmes inverses font l'objet d'un travail de recherche en imagerie cérébrale. Celui-ci repose sur le formalisme de Maximum d'Entropie en moyenne. Ces deux thèmes de recherche font l'objet de collaborations internationales (A. Arnéodo, CNRS, Fr. et H. Benali, INSERM, Fr.)

### *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 medallist) 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.

### *Jean Meunier*
**Traitements numériques d'images médicales**

Mes travaux de recherche portent sur l'estimation du mouvement tridimensionnel, le recalage, la comparaison de données volumiques et sur la construction d'atlas (modèle) numérique avec applications en imagerie médicale dans le but de faciliter une analyse tridimensionnelle de ces images par le médecin. Ces travaux se font avec la collaboration des grands hôpitaux universitaires montréalais et de l'Institut de génie biomédical de l'Université de Montréal et de l'École Polytechnique.

Plus particulièrement, en cinéangiographie biplan (séquences de radiographies obtenues selon deux vues) nous avons développé une approche d'autocalibrage des caméras qui ne requiert pas d'objet de calibrage (cube ou autres) contrairement aux autres méthodes classiques ceci afin de récupérer la forme et le mouvement 3D d'un objet comme le réseau coronarien. Cette méthode réduit considérablement la complexité du protocole d'acquisition des images puisqu'on n'a pas à utiliser de cube de calibrage après chaque examen d'un patient. Nous travaillons aussi au développement d'une méthode de reconstruction 3D à partir d'une seule vue (vision monoculaire) en se basant sur des connaissances a priori sur le réseau coronarien. Nous avons aussi développé une méthode pour construire un atlas numérique (modèle moyen avec les variations normales) du cerveau humain en utilisant un ensemble d'images de résonance magnétique obtenues chez des sujets sains. Ce modèle (atlas) possède deux importantes propriétés généralement absentes simultanément dans les autres atlas électroniques : une intensité moyenne et une forme moyenne des tissus du cerveau; il sera particulièrement utile pour aider à porter un diagnostic ou pour classifier des images. Nous travaillons présentement à étendre cette approche à la construction d'un atlas spatio-temporel du réseau coronarien du cœur en mouvement, à la modélisation géométrique de la cornée humaine et à l'imagerie SPECT (Single Photon Emission Computed Tomography utilisée en médecine nucléaire.)

### *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 remet en question 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 de la recherche de C. Rousseau porte sur les problèmes de finitude des cycles limites (cyclicité finie) dans les bifurcations des champs de vecteurs du plan avec applications aux bifurcations génériques de champs de vecteurs ainsi qu'à la partie finitude du 16e problème de Hilbert pour les systèmes quadratiques, laquelle découle de la cyclicité finie de 121 graphiques du plan. Des progrès très significatifs ont été accomplis: le premier avec les applications de la thèse de H. Zhu permettant de montrer 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.

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 with latent variables for

describing time series of counts and application in epidemiology;
Modelling of nonlinear time series using weak ARMA representations.

During the past year, with the Ph.D. student Pierre Duchesne, he has developed a class of robust tests for the hypothesis of independence of two univariate ARMA time series against the alternative of serial correlation of an arbitrary form between the two series.

### *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*
**Spectral Asymptotics**

I am interested in questions related to spectral statistics of quantum Hamiltonians and in problems of quantum chaos for integrable systems.
With Alain Bourget we have determined the asymptotic level-spacings distribution for the zeroes of the Lamé eigenfunctions and are currently working on the corresponding result

for more general quantum integrable spin chains.

In joint work with Yiannis Petredis, we have proved that the Hardy bound is attained for the Weyl counting function in a probabilistic sense, by averaging over the moduli space of flat metrics on tori. We also have analogous results for Heisenberg manifolds.

### *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 filed is a tool that has been used over the last decade to analyze 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 modeled 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) $c^2$, *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*

**Contrôle de problèmes d'évolution non cylindrique**

On considère des systèmes dynamiques issus de la mécanique des milieux continus dans lesquels le domaine géométrique (occupé par le milieu continu) est lui-même dynamique. Le mouvement des frontières et des interfaces est

lui-même un des paramètres de contrôle. La nécessité de travailler en régularité minimale et d'utiliser des formulations intrinsèques amène à revisiter les modèles EDP des systèmes mécaniques eux-mêmes.

Les exemples principaux abordés concernant d'une part les fluides newtoniens visqueux avec possiblement des frontières libres et des couplages fluides structures en grande déformation. Les fluides non newtoniens en régime quasi statique. L'élasticité et les codes électromagnétique en géométrie pilotée.

Le concept important est celui du champ transverse Z intervenant par une nouvelle équation d'état « pilotée » par le crochet de Lie [Z, V] où V est un champ dont le flux gouverne l'évolution des géométries.

Parmi les applications citons les travaux en cours avec Michel Delfour concernant la dynamique artérielle utilisant également les modèles intrinsèques de coques élastiques.

# 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. The following list of *Recent Titles* contains books that have appeared during the year 2000 –2001 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, 2000.
- Masayoshi Miyanishi, *Open Algebraic Surfaces*, vol. 12, 2001.
- Michael Baake & Robert V. Moody (eds.), *Directions in Mathematical Quasicrystals*, vol. 13, 2000.
- Joel Feldman, Horst Knörrer & Eugene Trubowitz, *Fermionic Functional Integrals and the Renormalization Group*.
- Eyal Z. Goren, *Lectures on Hilbert Modular Varieties and Modular Forms*, vol. 14 (to appear, October 2001) .
- Jose I. Burgos, *The Regulators of Beilinson and Borel*, vol.15 (to appear, November, 2001).

### AMS: CRM Proceedings & Lecture Notes

- 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, 2000.
- Israel M. Sigal & Catherine Sulem, *Nonlinear Dynamics and Renormalization Group*, vol. 27, 2001.
- J.C. Taylor (ed.), *Topics in Probability and Lie Groups: Boundary Theory*, vol. 28.
- Alan Coley, Decio Levi, Robert Milson, Colin Rogers & Pavel Winternitz (eds.), *Bäcklund and Darboux Transformations: The Geometry of Soliton*, vol. 29 (to appear, October 2001).
- John McKay & Abdellah Sebbar (eds.), P*roceedings on Moonshine and Related Topics*, vol. 30 (to appear, November 2001).
- Alexander R. Its & John Harnad (eds.), *Isomonodromic Deformations and Applications*, vol. 31 (to appear).

### Springer-Verlag: CRM Series in Mathematical Physics

- 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*, 2001.
- Marc Moore (ed.), Spatial Statistics, 2001.

### Les Publications CRM

- James G. Huard & Kenneth S. Williams (eds.), *The Collected Papers of Sarvadaman Chowla, I, II, III, 2000.*
- Nadia El-Mabrouk, Thomas Lengauer & David Sankoff (eds.), *Currents in Computational Molecular Biology 2001.*

# 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.
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- 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

- Pierre Hansen & Odile Marcotte (eds.), *Graph Colouring and Applications*, vol. 23, 1999.
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- Olga Karlampovich (ed.), *Summer School in Group Theory* (Banff, 1996), vol. 17, 1998.
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- 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.
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- Luc Vinet & Gordon Semenoff (eds.), *Particles and Fields* (Banff, 1994), CRM Series in Mathematical Physics, Springer, New York, 1998.

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- Decio Levi, Curtis R. Menyuk, & Pavel Winternitz, *Self-Similarity in Stimulated Raman Scattering* (Montréal, 1993), Montréal, 1994.
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- 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).

## Aisenstadt Chair Collection

- 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-2678] D. J. Rowe, H. de Guise, and B. C. Sanders, *Asymptotic limits of SU(2) and SU(3) Wigner functions*, July 2000.

[CRM-2679] A. Ramani, B. Grammaticos, S. Lafortune, and Y. Ohta, *Linearisable mappings and the low-growth criterion*, July 2000.

[CRM-2680] L. Lapointe, A. Lascoux, and J. Morse, *A filtration of the symmetric function space a refinement of the Macdonald positivity conjecture*, August 2000.

[CRM-2681] A. Ramani, B. Grammaticos, and S. Tremblay, *Integrable systems without the Painlevé property*, August 2000.

[CRM-2682] S. Tremblay, B. Grammaticos, and A. Ramani, *Integrable lattice equations and their growth properties*, August 2000.

[CRM-2683] D. Levi, S. Tremblay, and P. Winternitz, *Lie point symmetries of difference equations and lattices*, August 2000.

[CRM-2684] D. Dryanov and R. Fournier, *On Visser's inequality*, August 2000.

[CRM-2685] Richard Fournier, *Some remarks on Jack's lemma*, August 2000.

[CRM-2686] A. Joffe, É. Marchand, F. Perron, and P. Popadiuk, *On a particular sum of dependent {B}ernoulli and its relationship to a matching type problem*, August 2000.

[CRM-2687] C. Christopher, P. Mardesic, and C. Rousseau, *Normalizable, integrable and linearizable saddle points in complex quadratic systems in* $\mathbf{C}^2$, August 2000.

[CRM-2688] M. B. Sheftel, P. Tempesta, and Pavel Winternitz, *Superintegrable systems in quantum mechanics and classical Lie theory*, September 2000.

[CRM-2689] R. {Hernandez Heredero}, D. Levi, and P. Winternitz, *Relation between backlund transformations and higher continuous symmetries of the Toda equation*, September 2000.

[CRM-2690] C. Amblard and S. Girard, *Symmetry and dependence properties within a semiparametric family of bivariate copulas*, September 2000.

[CRM-2691] A. Boivin, P. M. Gauthier, and P. V. Paramonov, *Approximation on closed sets by analytic or meromorphic solutions of elliptic equations and applications*, September 2000.

[CRM-2691a] Jamila Karrakchou, *On output stabilization of discrete linear delay systems*, September 2000.

[CRM-2692] François Dubeau and Jamila Karrakchou, *Équations différentielles à retard avec une infinité d'impulsions qui dépendent de l'état*, September 2000.

[CRM-2693] A. El Boukili, A. Madrane, and Rémi Vaillancourt, *Adaptive techniques for semiconductor equations with a Raviart-Thomas element*, September 2000.

[CRM-2694] M. Bilodeau, *Asymptotic distribution of the largest eigenvalues for underlying elliptical distributions*, October 2000.

[CRM-2695} D. Levi, S. Tremblay, and P. Winternitz, *Continuous symmetries of equations on lattices*, October 2000.

[CRM-2696} M. Bilodeau, *Asymptotic distribution of the largest eigenvalue*, November 2000.

[CRM-2697] F. Dumortier, Y. Ilyashenko, and C. Rousseau, *Normal forms near a saddle-node and applications to finite cyclicity of graphics*, October 2000.

[CRM-2698] B. Eynard, *Asymptotics of skew orthogonal polynomials*, December 2000.

[CRM-2699] J. Harnad, *Dual isomonodromic tau functions and determinants of integrable Fredholm operators*, December 2000.

[CRM-2700] C. Amblard, E. Lapalme, and J.-M. Lina, *Biomagnetic cortical sources detection by maximum entropy on the mean*, December 2000.

[CRM-2701] Dana Schlomiuk and Nicolae Vulpe, Planar quadratic differential systems with invariant straight lines

[CRM-2702] F. H. Clarke, L. Rifford, and R. J. Stern, *Feedback in state constrained optimal control*, December 2000.

[CRM-2703] P. Duchesne and R. Roy, *Consistent tests for independence against serial dependence of unknown form in vector time series models*, January 2001.

[CRM-2704] M. Bilodeau and P. Duchesne, *Robust estimation of the SUR model*, January 2001.

[CRM-2705] M. Bilodeau and P. Duchesne, *Principal component analysis from multivariate familial correlation matrix*, January 2001.

[CRM-2706] F. Dubeau, A. Ouansafi, and A. Sakat, *Approximation de la solution d'une équation différentielle ordinaire avec impulsions qui dépendent de l'état*, January 2001.

[CRM-2707] P. Bouchard, J.-F. Angers, and É. Bossé, *A new fuzzy inference engine applied to identify information fusion*, January 2001.

[CRM-2708] F. Dumortier, A. Guzmán, and C. Rousseau, *Finite cyclicity of elementary graphics surrounding a focus or center in quadratic systems*, January 2001.

[CRM-2709] Bertrand Eynard, *Random matrices*, Saclay lecture notes, January 2001.
[CRM-2710] B. Toni, *Cyclicity of isochronous centers*, February 2001.
[CRM-2711] P.-L. Buono, J. S. W. Lamb, and M. Roberts, *Steady-state bifurcations in reversible equivariant systems*, February 2001.
[CRM-2712] P. Arminjon, A. Madrane, and A. St-Cyr, *Numerical simulation of 3D flows with a non-oscillatory central scheme on unstructured tetrahedral grids*, February 2001.
[CRM-2713] J. Hernàndez-Loreto and B. Toni, *Ciclos límite de primer orden de una 1-forma linearizable*, February 2001.
[CRM-2714] J. Hernàndez-Loreto and B. Toni, *Periodos críticos y clasificación de centros de un sistema cúbico*, February 2001.
[CRM-2715] B. Toni, *Differential dynamics in terms of {J}acobian loops*, February 2001.
[CRM-2744] J. Chavarriga and D. Schlomiuk, *Integrability criteria for differential equations on the projective plane*, May 2001.
[CRM-2745] S. Gravel and P. Thibault, *Integrability and linearizability of the Lotka-Volterra system with a saddle point with rational hyperbolicity ratio*, November 2000.
[CRM-2764] R. Collobert, S. Bengio, and Y. Bengio, *A parallel mixture of SVMs for very large scale problems*, 2001.
[CRM-2765] P. Vincent and Y. Bengio, *K-local hyperplane and convex distance nearest neighbor algorithms*, 2001.
[CRM-2766] I. Takeuchi, Y. Bengio Y., and T. Kanamori, *Robust regression with asymmetric heavy-tail noise*, 2001.
[CRM-2767] N Chapados, Y. Bengio, P. Vincent, J. Ghosn, C. Dugas, I. Takeuchi, and L. Meng, *Estimating car insurance premia: a case study in high-dimensional data inference*, 2001.
[CRM-2768] Y. Bengio and N. Chapados, *Extending metric-based model selection and regularization in the absence of unlabeled data*, 2001
[CRM-2769] F. Bergeron, N. Bergeron, and J.-C. *Aval, lattice diagram polynomials in one set of variables*, March 2001.
[CRM-2770] S. Boyer, *On the local structure of SL(2, **C**)-character varieties at reducible characters*, 2001
[CRM-2771] S. Boyer, E. Luft, and X. Zhang, *On the algebraic components of the $SL_2(C)$-character varieties of knot exteriors*, 2001.
[CRM-2772] R. C. Brunet, *From population to proportion dynamics for epidemiological models with heterogeneity*, 2001.
[CRM-2773] M. Bouchard, R. C. Brunet, P.-O. Droz, and G. Carrier, *A biologically-based dynamic model for predicting the disposition of methanol and its metabolites in animals and humans*, 2001
[CRM-2774] M. Bouchard, R. C. Brunet, P.-O. Droz, and G. Carrier, *A biologically-based dynamic model for predicting the disposition of formaldehyde and its metabolites in animals*, 2001
[CRM-2775] H. Darmon and P. Green, *Elliptic curves and class fields of real quadratic fields: algorithms and evidence*, 2001.
[CRM-2776] H. Darmon, *Integration on $H_p \times H$ and arithmetic applications*, 2000.
[CRM-2777] M. Bertolini and H. Darmon, *Iwasawa's main conjecture for elliptic curves over anticyclotomic $\mathbf{Z}_p$-extensions*,2001.
[CRM-2778] M. Bertolini, H. Darmon, A. Iovita, and M. Spiess, *Teitelbaum's exceptional zero conjecture in the anticyclotomic setting*, 2001.
[CRM-2779] D. Dufresne, *On general class of risk models*, 2001.
[CRM-2780] N. El-Mabrouk and D. Sankoff, *The reconstruction of doubled genomes*, 2001.
[CRM-2781] N. El-Mabrouk, *Reconstructing an ancestral genome using minimum segments duplications and reversals*, 2001.
[CRM-2782] M. Frigon, *Remarques sur l'enlacement en théorie des points critiques pour des fonctionnelles continues*, May 2001.
[CRM-2783] M. J. Gander, F. Magoules and F. Nataf, *Optimized Schwarz methods without overlap for the Helmholtz equation*, April 2001.
[CRM-2784] M. J. Gander and L. Halpern, *Un algorithme discret de décomposition de domaines pour l'équation des ondes en dimension 1*, 2001.
[CRM-2785] M.J. Gander and L. Halpern, *Méthodes de décomposition de domaines pour l'équation des ondes en dimension 1*, 2001.
[CRM-2786] M. J. Gander, *Optimized Schwarz Methods for Helmholtz Problems*, 2001
[CRM-2787] D. S. Daoud and M. J. Gander, *Overlapping Schwarz Waveform Relaxation for Convection Reaction Diffusion Problems*, 2001.
[CRM-2788] M. J. Gander, L. Halpern, and C. Japhet, *Optimized Schwarz algorithms for coupling convection and convection-diffusion problems*, 2001.
[CRM-2789] M. J. Gander and H. Zhao, *Overlapping Schwarz waveform relaxation for the heat equation in n-dimensions*, 2001.
[CRM-2790] M. J. Gander, L. Halpern and F. Nataf, *Optimal Schwarz waveform relaxation for the one dimensional wave equation*, 2001.

[CRM-2791] M. J. Gander and A. Ruehli, *Optimized waveform relaxation methods for diffusive type circuits*, 2001.

[CRM-2792] D. S. Daoud and M. J. Gander, *Overlapping Schwarz waveform relaxation for convection reaction diffusion problems*, 2001

[CRM-2793] M. J. Gander, *Optimized Schwarz Methods for Symmetric Positive Definite Problems*, 2001

[CRM-2794] M. J. Gander and C. Rohde, *Overlapping Schwarz waveform relaxation for convection dominated dissipative conservation laws*, 2001

[CRM-2795] P. Gora, P. Bracken and A. Boyarsky, *Deriving chaotic dynamical systems from energy functionals*, 2001

[CRM-2796] P. Gora, P. Bracken and A. Boyarsky, *A minimum principle in chaotical dynamical systems*, 2001

[CRM-2797] P. Gora and W. Bahsoun, *Exact inner functions*, 2001

[CRM-2798] P. Gora and A. Boyarsky, *Absolutely continuous invariant measures for random maps with position dependent probabilities*, November 2000

[CRM-2799] P. Gora and N. Obeid, *Absolutely continuous invariant measures for a class of meromorphic transformations*, 2001

[CRM-2800] P. Gora and A. Boyarsky, *On the discrete nature of time*, 2000.

[CRM-2801] P. Gora and A. Boyarsky, *Chaotic maps derived from data*, 2001 .

[CRM-2802] P. Gora and A. Boyarsky, *A dynamical system interpretation of irreducible complexity*, 2001.

[CRM-2803] P. Gora and A. Boyarsky, *Control in a class of chaotic unimodal maps*, 2001.

[CRM-2804] P. Gora and A. Boyarsky, *Deterministic description of quantum mechanics*, 2001.

[CRM-2805] Ph. Saint-Jean, J.-M. Lina, and B. Goulard, *Irregular random fields, wavelets and Euler characteristics*, 2000.

[CRM-2806] J.-M. Lina, D. Clonda, and B. Goulard, *Complex dyadic wavelets: statistical modeling and image processing*, 2001.

[CRM-2807] D. Clonda, J.-M Lina, and B. Goulard, *Mixed memory model for image processing and modeling with complex Daubechies wavelets*, 2000

[CRM-2808] J. C. Hurtubise and E. Markman, *Surfaces and the Sklyamin bracket*, 2001.

[CRM-2809] D. Jakobson and N. Nadirashvili, *Quasi-symmetry of $L_p$ norms of eigenfunctions*, 2001

[CRM-2810] D. Jakobson and I. Rivin, *Extremal metrics on graphs*, 2001

[CRM-2811] C. Klein, D. Korotkin, and V. Shramchenko, Ernst equation, *Fay identities and variational formulas on algebraic curves*, 2001

[CRM-2812] D. Korotkin, K. Korotkov, and B. Krylov, *On classification of gas discharge images around fingers and drops of liquid*, 2001

[CRM-2813] D. Korotkin, *On some integrable system arising in differential geometry and general relativity*, 2001.

[CRM-2814] F. Lalonde and M. Pinsonnault, *Topology of the space of symplectic embeddings of the ball in a 4-dimensional rational manifold*, 2001.

[CRM-2815] F. Lalonde and D. McDuff, *Cohomological properties of ruled symplectic manifolds*, 2000

[CRM-2816] D. J. Ford and J. McKay, *Monstrous Moonshine—Problems arising I. Tate characters*, 2001

[CRM-2817] D. J. Ford and J.McKay, J., *Monstrous Moonshine—Problems Arising II. The Monster and affine $E_8$ Dynkin data*, 2001.

[CRM-2818] L. Haddad, H. Machida, and I. G. Rosenberg, *Maximal and minimal partial clones*, 2000.

[CRM-2819] L. Haddad, D. Lau, and I. G. Rosenberg, *Intervals of partial clones containing maximal clones*, 2000

[CRM-2820] A. A. Krokhin and I. G. Rosenberg, *A monoidal interval of clones of autodual functions*, 2001.

[CRM-2821] F. H. Clarke and R. Stern, *Hamilton-Jacobi characterization of the state constrained value*, 2001.

[CRM-2822] F. Gungor and P. Winternitz. *Generalized Kadomtsev-Petviashvili equation with an inifinite dimensional symmetry algebra*, 2001.

[CRM-2823] G. S. Pogosyan and P. Winternitz. *Separation of variables and subgroup bases on n-dimensional hyperboloids*, 2001.

[CRM-2824] S. Frittelli, N, Kamran, T. Newman, *Differential equations and conformal geometry*, 2000.

[CRM-2825] F. Finster, N. Kamran, J. Smoller and S.-T. Yau, *The long-time dynamics of Dirac particles in the Kerr-Newman black hole*, 2001.

[CRM-2826] F. Finster, N. Kamran, J. Smoller and S.-T Yau, *Decay rates and probability estimates for Dirac particles in the Kerr-Newman geometry*, 2001.

# Financial Report

The CRM benefits from several 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 2000-2001, the CRM received a second instalment of $874,650 of a four-year NSERC institutes grant. This grant enables the Centre to fulfil its national mandate focussed on the organization of scientific activities each year (postdoctoral fellowships, student scholarships, visiting researchers, thematic scientific program as well as a general program of scientific activities, and research support personnel). (For more details, see below the section titled "Financial statements".)

The Comité d'étude et d'administration de la recherche (CÉDAR) of the Université de Montréal provided an operating grant of $814,426 in 2000-2001. This budget is principally allocated for the remuneration of the scientific personnel of the Centre. The budget also covers the release time of the faculty members who direct the CRM and a part of the salary of administrative staff as well as some operating and computer expenses. The Université de Montréal also contributed an additional $40,000 for a visiting researcher.

The Fonds FCAR also supports the operations of the CRM. The Centre received the second instalment of $210,000 of a three-year operating grant in 2000-2001. This grant 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.

The CRM manages the collective scientific activities and the general administration of the Network for Computing and Mathematical Modeling (nc$m_2$). A budget of $70,894 was allocated for these tasks in 2000-2001. In addition, the CRM received $80,000 from the Network to finance the research projects of four of its members. These amounts come from the Network's annual NSERC grant of $648,894. The balance of this amount goes to the research projects of the four other founding centres of nc$m_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 which jointly established the Mathematics of Information Technology and Complex Systems Network of Centres of Excellence (MITACS), the CRM supervises the activities of six of the Network's research projects. It also promotes networking activities. The CRM received $125,000 in 2000-2001 for these tasks from the overall NCE funding provided to MITACS. In addition, the research projects just mentioned received $660,000 in NCE funding in 2000-2001 (see the note below Table 3).

The CRM also obtained grants for two postdoctoral fellowships from the Alfred P. Sloan Foundation (US$50,000) and from the Heart & Stroke Foundation of Canada ($33,561). A grant of $11,000 from the Ministère de la Culture et des Communications du Québec's programme assisting in the popularization of science (*Étalez votre science*). The CRM's André Aisenstadt endowment contributed revenues of $55,037 in 2000-2001. These funds serve for the Centre's scientific activities, particularly the annual André Aisenstadt Prize and Aisenstadt Chairs).

Other contributions to the CRM's funding from universities and partner organizations, totalling $280,095, come from the Institut des sciences mathématiques (ISM) for joint CRM-ISM postdoctoral fellowships and the joint colloquium series; from researchers of the Montréal universities for joint postdoctoral fellowships and student scholarships; and from the Canadian Institute for Advanced Research (CIAR). In addition, there were several contributions for the 2000-2001 thematic year: $10,000 from CERCA for two symposiums (NARI and MFRS); a $5,000 sponsorship from Guidant for the workshop on Mapping and Control of Complex Arrhythmias; and a sponsorship of $500 from Boehringer Ingelheim (Canada) Ltd for the NARI symposium.

The CRM generated revenues of $66,487 from its publishing programs (sales and royalties from the CRM's series with the American Mathematical Society and Springer-Verlag New York, and from the CRM's in-house collection) and $60,167 from registration fees to scientific activities (thematic year, CRM summer school, CRM-MITACS spring school). Other funds came from compensation for services rendered and operating costs. A small revenue from the sale of t-shirts, coffee cups and posters completes the picture of the Centre's income sources.

### Table 1

**Main sources of funding of the CRM, 2000-2001**

| | $ Amount |
|---|---|
| NSERC (Institutes and Initiatives Program) | 874,650 |
| Université de Montréal (incl. CÉDAR) | 854,426 |
| FCAR (Research Centres Program) | 210,000 |
| NSERC (Research Network Program, nc$m_2$) | 150,894 |
| National Centres of Excellence (MITACS) | 125,000 |
| Contribution from universities & partners | 280,095 |
| Other grants and revenue from endowments | 173,648 |
| Sales, Registration fees & other revenues | 142,220 |
| **Total** | **2,810,934** |

In these tables, amounts are rounded to the nearest dollar.

## Funding for Research

In addition to the CRM's grants, its researchers obtained $2,071,438 in research funding during the 2000-2001 fiscal year. The two following tables provide details on funding awarded by granting agency and by category 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, 2000-2001**

| Granting agency | Number | $ Amount | *$ in Account at CRM* |
|---|---|---|---|
| NSERC | 39 | 956,210 | 230,895 |
| NSERC-nc$m_2$ [1] | 5 | 120,000 | 80,000 |
| FCAR | 9 | 232,952 | 37,000 |
| FCAR-Equipment | 3 | 142,349 | 0 |
| NCE-MITACS [2] | 4 | 85,725 | 5,000 |
| NCE-IRIS | 1 | 60,000 | 0 |
| Others | 4 | 133,342 | 0 |
| Total | **65** | **1,730,578** | **352,895** |

### Tableau 3

**Research partnerships: contracts and grants from industry, foundations, etc., CRM researchers, 2000-2001**

| Partner | Number | $ Amount | $ in Account at CRM |
|---|---|---|---|
| Bell University Laboratories | 3 | 185,645 | 185,645 |
| nc$m_2$ (ANIQ, Lockheed Martin, partners of GIREF, Bell University Laboratories, Insurance Co. of B. C.) | 5 | 109,215 | 69,175 |
| MITACS [2] (Bell University Laboratories) | 1 | 35,000 | 0 |
| Lockheed Martin | 1 | 11,000 | 11,000 |
| *Total* | **10** | **340,860** | **265,820** |

1. These amounts are accounted in the Centre's funding and the financial statements found in this annual report.

2. The total amount of the NCE-MITACS funding awarded to the six projects supervised by the CRM is $660,000 (of which $85,725 was awarded to members of the CRM). The industrial partners of these six MITACS projects contributed $238,351 (of which $35,000 was obtained by researchers of the CRM).

## 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, 2001. 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; travel and accommodation expenses of invited researchers (this includes the Aisenstadt Chairs 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 program; the 2000 summer school; the general scientific program made up of

contributions to off-site scientific activities and events, mini-programs on particular topics, colloquia organized jointly with the ISM, and 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 in Statistics); and finally, the scientific programs (workshops, seminars, lectures, conferences) of the two networks, MITACS and nc$m_2$;

- the *personnel* involved directly in the organization and management 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 production costs associated with the CRM's publishing programmes (remuneration of personnel preparing publications as well as direct costs such as printing of in-house collection publications).

Finally, the rubric *Administration* covers the remuneration of the CRM's executive, the administrative personnel, the computer systems analysts (who support the Centre's network, hardware and software used in its scientific, management, communications and administrative activities), and the communications personnel (Web, newsletter and annual report), as well as expenses related to executive and advisory business meetings, current operating costs, and computer equipment and maintenance costs.

The 2000-2001 year-end surplus is minimal.