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Presenting the annual report 2003-2004

François Lalonde, Director of CRM



The 2003-2004 year, thinking particularly about the thematic program in Geometric and Spectral Analysis, was certainly one of the greatest theme years ever organized by the CRM. It was a veritable firework of activities, discoveries, and unexpected collaborations; a year orchestrated with great intelligence and insight by Jacques Hurtubise who was able to bring about the concentrated state of effervescence

and dynamism that characterizes moments of great discoveries. That year was supervised by CRM Acting Director, my colleague Christian Léger, to whom we owe a great deal: he combined a rigorous administration, giving generously of his time with great devotion and attention to details. The CRM hosted over 1750 participants and visitors in 2003-2004 within the context of its thematic, general and industrial programs.

The thematic program drew over 500 participants, 15 long-term visitors and five year-long postdoctoral fellows. It included three mini-courses and two Aisenstadt Chair lecture series (given by S.T. Yau and Peter Sarnak), and especially a record number twelve workshops spread over the year, including one organized with AARMS (Atlantic Canada) and two with the Fields Institute (Toronto) as part of their thematic program in Partial Differential Equations. The last issue of the Bulletin du CRM (Fall 2004) published a superb retrospective of the year written by Iosif Polterovich. The year was organized by Bierstone, Craig, Finster, Jakobson, Jaksic, Kamran, Last, Melrose, Milman, Pilet, Phong, Polterovich, Toth and Zelditch.

The general program (which is non-thematic) was not outdone. It hosted a Workshop on Algebraic Structures and Moduli Spaces organized by Markman and Nakajima, the 61st Colloque des Sciences mathématiques du Québec held in April 2004 at CRM,

and A Workshop on Graph Theory in honour of Bondy and Fleischner in May 2004. The industrial and multidisciplinary program was plentiful with eleven workshops and events organized in collaboration with MITACS, ncm2, CIRANO, IEEE, IFM, GERAD and SSC. One of these, DeMoSTAFI (Dependence Modelling in Statistics and Finance) resulted in special issues in two journals: the Canadian Journal of Statistics and Insurance: Mathematics and Economics, the journal of reference in actuarial science.

The eight research laboratories (thematic research groups) of the CRM, having just completed a year of existence, organized a very nice conference in honour of Paul Koosis on Classical Analysis (see the article in the Fall 2004 issue of Bulletin du CRM), a CICMA Workshop on Computational Perspectives on L-Functions and p-adic Cohomology organized by Darmon and Pila, a Workshop on Functional Data Analysis organized by Léger in Ramsay (Statistics Laboratory), the Montreal Scientific Computing Days now a well-established tradition thanks to Bourlioux and Gander of the Applied Mathematics Laboratory, and a Workshop on Tau Functions organized by CIRGET. These laboratories are a remarkable achievement: some existed for a number of years thanks to the foresight of FCAR in financing research teams (be they specialized or multidisciplinary) with its infrastructure grants program of the 1990s. Thanks to ISM, ten now well-established scientific groups have seen the light of day in the last decade. The CRM's laboratories have permitted a further advance by offering secure funding and a more direct access to the CRM's infrastructure to these groups. It has resulted in a more acute sense of collegiality and community, which has given a fresh impetus to mathematical research. These eight laboratories supported by CRM are the source of the most fruitful initiatives; it is in them that the CRM draws its resources and its originality. Thanks to them and the devoted members of the Scientific Advisory Committee, the programs of the CRM, which was one of the first two or three centres in the world to see the value of thematic synergy, remain a prime worldwide example in this domain.

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Scientific Programs 2003-2004

Theme Year 2003-2004: Geometric and Spectral Analysis

The core of each year's scientific program at the CRM is its thematic program. The Scientific Advisory Committee chose for 2003-2004 the theme of Geometric and Spectral Analysis because of its importance, timeliness and impact on the international scientific community. The thematic program included several workshops and conferences, two Aisenstadt Chair lecture series (Yau and Sarnak), a number of visiting scientists in residence, and some postdoctoral fellowships. In coordination with Montréal universities, CRM offers appropriate short courses in order to help graduate students participate in the activities. *The reports are presented in the language in which they were submitted.*



Organizing Committee

E. Bierstone (Toronto), W. Craig (McMaster), F. Finster (Regensburg), D. Jakobson (McGill), V. Jaksic (McGill), N. Kamran (McGill), Y. Last (Hebrew), R. Melrose (MIT), P. Milman (Toronto), C. Pillet (Toulouse), D.H. Phong (Columbia), I. Polterovich (Montréal), J. Toth (McGill), S. Zelditch (Johns Hopkins).

Overview

Analysis has traditionally stood at the center of a wide spectrum of research activities 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 now touch in an important way onto areas such as number theory and algebraic geometry. They are at the core of several of the deepest and most spectacular advances in these fields.

The thematic year in geometric and spectral analysis focussed 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 a short programme on analysis on sin-

gular spaces, and a more extended period on spectral analysis in geometry, mathematical physics and number theory. 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 for a balance between the geometric and spectral components of the scientific programme, and also with the objective of highlighting some of the most interesting current applications of analytic ideas to physics.

There was be a strong emphasis on training through the short courses which preceded the proposed workshops, as well as through the coordination of the graduate course offerings in analysis and geometry in the Montreal universities.

Aisenstadt Chair Lecture Series: Yau & Sarnak

As always, among the highlights of the year were the lectures given by the Aisenstadt Chairs. The first series of the Aisenstadt lectures was delivered by Shing-Tung Yau (Harvard). He gave a broad survey of the analytical problems that arise in the study of isolated systems in general relativity, culminating with a fascinating new definition of quasi-local mass recently discovered together with his student Melissa Liu (Ph.D. 2002, Harvard). The positivity properties of this mass were developed in detail. Professor Yau's lectures were part of the Workshop on the Interaction of Gravity with Classical Fields, organized by Felix Finster (Regensburg) and Niky Kamran (McGill). This workshop was preceded by another one, devoted to the Cauchy problem for the Einstein equations, also organized by Finster and Kamran. The Riemannian Penrose inequality, the conformal Einstein equations and the nonlinear stability of Minkowski space were among the topics covered during this event.

The other series of the Aisenstadt lectures was given by Peter Sarnak (NYU and Princeton) at the Workshop on Spectral Theory and Automorphic Forms, organized by Dmitry Jakobson (McGill) and Yiannis Petridis (CUNY). Professor Sarnak gave a general introduction on the spectrum of the modular group, followed by a discussion of the latest research on the relation between quantum and classical fluctuations. His last lecture on lattice packings in higher dimensions was based on a joint work with Andreas Strömbergsson (Ph.D. 2001, Uppsala). One of the recent breakthroughs in the field was E. Lindenstrauss's proof of the Rudnick-Sarnak quantum unique ergodicity conjecture for arithmetic surfaces. Lior Silberman (Ph.D. student, Princeton) and Akshay Venkatesh (Ph.D. 2002, Princeton) reported on their extension of this proof to locally symmetric spaces.

Short programme on analysis and resolution of singularities

August 18-September 5, 2003

Org.: E. Bierstone (Toronto), R. Melrose (MIT), P. Milman (Toronto), D.H. Phong (Columbia).

Speakers: Janusz Adamus (Toronto), Jochen Brüning (Humboldt), Sagun Chanillo (Rutgers), Xiuxiong Chen (Wisconsin-Madison), Michael Christ (Berkeley), Andrew Comech (Duke), John P. D'Angelo (Illinois, Urbana-Champaign), Klas Diederich (Wuppertal), Lawrence Ein (Illinois at Chicago), Charles Louis Fefferman (Princeton), Akito Futaki (Tokyo, Inst. of Technology), Caroline Grant Melles (US Naval Academy), Michael Greenblatt (Wisconsin-Madison), Allan Greenleaf (Rochester), Daniel Grieser (Bonn), Eugénie Hunsicker (Lawrence), Jacques Hurtubise (McGill), Niky Kamran (McGill), Robert Lazarsfeld (Michigan), Ben Lichtin (Rochester), John Loftin (Columbia), Zhiqin Lu (UC Irvine), Toshiki Mabuchi (Osaka), George Marinescu (Humboldt), Rafe Mazzeo (Stanford), Mircea Mustata (Clay Mathematics Inst.), Andreea C. Nicoara (Harvard), Takeo Ohsawa (Nagoya), Wieslaw Pawlucki (Jagiellonian), Markus Pflaum (Johann Wolfgang Goethe-Univ.), Malabika Pramanik (Wisconsin-Madison), Leslie D. Saper (Duke), Yum-Tong Siu (Harvard), Karen E. Smith (Michigan), Jian Song (Columbia), Jacob Sturm (Rutgers), S. Tankeev (Vladimir State Technical Univ.), John A. Toth (McGill), Alexander Varchenko (North

Carolina at Chapel Hill), Sophia Vassiliadou (Georgetown), Stephen Wainger (Wisconsin-Madison), Ben Weinkove (Columbia), Jaroslaw Włodarczyk (Purdue), James Wright (Edinburgh), Jared Wunsch (Northwestern) Chan Woo Yang (Johns Hopkins), Maciek Zworski (Berkeley).

Number of participants: 62

The Short Program on Analysis and Resolution of Singularities was the first major activity in CRM's Thematic Year on Geometry and Spectral Theory. The Short Program was unique in bringing together researchers in algebraic geometry, complex differential geometry and partial differential equations. It was organized in three separate weeks:

1. Workshop on oscillatory integrals and critical integrability exponents

The topics included degeneracy of holomorphic functions in several variables, Tian-Yau invariants of complex manifolds, degenerate Fourier integral operators and Legendre distributions, multiplier ideal sheaves and jet schemes.

2. Short courses

Three mini-series of four lectures each, accessible to graduate students: *Resolution of singularities (from an analyst's point of view)*, E. Bierstone (Toronto), *Singularities in harmonic and geometric analysis*, D.H. Phong (Columbia), and *Metrics, fibrations and singular spaces*, R. Melrose (M.I.T.).

3. Workshop on resolution of singularities, metrics and the Laplacian

The workshop was directed towards the differential topology of, and differential analysis on, singular spaces, especially algebraic varieties. The general problem of the appropriate definition of the Laplacian, and correspondingly harmonic forms, was extensively discussed with emphasis on unresolved questions concerning the domain of the Laplacian and the regularity and structure of Hodge and weighted deRham forms.

A particular focus was a description of harmonic forms on singular projective varieties via an understanding of the structure of the Fubini-Study metric lifted to a resolution.

The program was particularly successful in bringing together not only researchers in different mathematical areas, but also leading experts, students and postdocs. The large number of younger participants reflected the great current interest of the main topics. Several of the speakers in each workshop were postdoctoral fellows.

The program was organized to stimulate progress on problems in geometric and harmonic analysis that had led to the first interactions between multiplier ideal sheaves and partial differential equations in complex geometry, between resolution of singularities and oscillatory integrals, and between desingularization of the Fubini-Study metric and harmonic analysis on singular spac-

es. It was highly successful – researchers in these areas were able to get first-hand insight into each other’s work, and advances on the main problems began even during the meeting. (For example, a problem discussed by Melrose on desingularization of the Fubini-Study metric can be solved in the case of toric varieties using a combinatorial desingularization algorithm of Bierstone-Milman discussed also during the second week.)

Workshop on the Cauchy problem for the Einstein equations

September 24-28, 2003

Org.: F. Finster (Regensburg), N. Kamran (McGill)

Speakers: Abhay Ashtekar (Pennsylvania State), Adrian Butscher (Toronto), Matthew W. Choptuik (UBC), Piotr Chrusciel (Tours), Helmut Friedrich (Max-Planck-Institut), Greg Galloway (Miami), Gerhard Huisken (Max-Planck-Institut), James Isenberg (Oregon), Jerzy Kijowski (Center for Theoretical Physics), Jerzy Lewandowski (Warszawski), Ezra T. Newman (Pittsburgh), Francesco Nicolò (Roma “Tor Vergata”), Daniel Pollack (Washington), Harald Schmid (Regensburg).

Number of participants: 27

This workshop brought together some of the world’s leading experts in the study of the Cauchy problem for the Einstein field equations of general relativity. This is a question of paramount physical importance in trying to understand the formation of singularities and black holes. It is also an extraordinary challenge for mathematicians interested in non-linear hyperbolic and parabolic partial differential equations.

The workshop opened with four extremely useful introductory lectures by Abhay Ashtekar and Gerhard Huisken, who reviewed the geometric, analytic and physical foundations of the problem, including the positivity of mass, the asymptotic structure at spatial and null infinity and the Penrose inequality. These introductory lectures were followed by more specialized lectures covering the proof of the Riemannian Penrose inequality by Bray and Huisken/Ilmanen, the stunning results of Christodoulou on the cosmic censorship conjecture for spherically symmetric gravitational fields, the proof by Klainerman-Nicolò of the global non-linear stability of Minkowski space-time using double null foliations, the new formulation of the conformal Einstein equations by Helmut Friedrich, the smoothness problem for conformal infinity by Piotr Chrusciel, and the search for the optimal Sobolev exponent (how to get from $5/2$ to 2 ?) by Klainerman and Rodnianski. Jim Isenberg gave a marvelous lecture entitled “what we know and don’t know about the constraint equations” which was a tour-de-force of synthesis and exposition. Overall, there was an extraordinary sense of continuity in the lectures, which were an extremely stimulating experience for the students and experts alike.

Workshop on the interaction of gravity with classical fields

October 1-5, 2003

Org.: F. Finster (Regensburg), N. Kamran (McGill).

Speakers: Stephen Anco (Brock), Håkan Andreasson (Chalmers Univ. of Technology), Brandon Carter (LUTH, Observatoire de Paris-Meudon), Mihalis Dafermos (MIT), Peter Forgacs (Tours), Hiroko Koyama (National Astronomical Observatory), Jutta Kunz (Oldenburg), Hans-Peter Kunze (Alberta), Alexander Linden (Canberra), Dieter Maison (Max Planck Institut), Raymond G. McLenaghan (Waterloo), Éric Poisson (Guelph), Antonio Sa Barreto (Purdue), Harald Schmid (Regensburg), Avy Soffer (Rutgers), John Stalker (Princeton), Bernard Whiting (Florida), Shing-Tung Yau (Harvard).

Number of participants: 26

The interaction of gravity with classical fields leads quickly to some very deep questions of physical and analytical interest, such as the possible absence of space-time singularities when gravity is coupled to a non-Abelian gauge field or a fermion field, or the linear stability of rotating black holes. Indeed, Birkhoff’s theorem asserts that pure gravity does not exhibit any dynamical behavior, so that the presence of non-trivial dynamics requires that gravity be coupled to a matter field.

The remarkable and totally unexpected discovery through numerical methods by Bartnik and McKinnon of the existence of everywhere regular, localized solutions of the Einstein Yang-Mills equations, and the subsequent proof by Finster, Smoller and Yau of the existence of stable regular localized spherically symmetric solutions of the Einstein Yang-Mills equations gave a tremendous impetus to the area, where the non-linear interaction of gravity with repulsive forces is surprisingly seen to give rise to stable solutions for certain ranges of the coupling constants. The workshop brought together some of the world’s leading players in the subject and was held in conjunction with Shing-Tung Yau’s Aisenstadt lectures on mathematical analysis in general relativity.

Again, there were opening lectures on the foundations of the subject, given by P. Forgacs and H. Kunze. The highlights of the lectures included a talk by Mihalis Dafermos on his stunning proof of Price’s law for the decay of scalar fields coupled to gravity, lectures by Dieter Maison on “colored black holes”, Avy Soffer on decay of non-linear waves in Schwarzschild geometry, Brandon Carter on gravitating branes, Hakan Andreasson on the existence of solutions to the Einstein Vlasov system, and Felix Finster on wave equations in the Kerr metric. One of the hopes that emerged as a result of this workshop is that a proof of the linear stability of the Kerr black hole for perturbations involving infinitely many modes may be within reach. This would have been unlikely even ten years ago.

Workshop on large N limits of $U(N)$ gauge theory in physics and mathematics

January 5-9, 2004

Org.: P. Bleher (IUPUI), V. Kazakov (École Normale) et S. Zelditch (Johns Hopkins)

Speakers: Marco Bertola (Concordia), Michael Douglas (Rutgers), Charlie Frohman (Iowa), William M. Goldman (Maryland), Alice Guionnet (ENS de Lyon), John Harnad (Concordia), Dmitry Korotkin (Concordia), Ivan Kostov (SPHT Saclay), Andrei Okounkov (Princeton), Nicolai Reshetikhin (Berkeley), Mariya Shcherbina (Ukrainian Ac. Sci.), Matthias Staudacher (Albert-Einstein-Institut), Richard Wentworth (Johns Hopkins), Christopher Woodward (Rutgers), Ofer Zeitouni (Minnesota).

Number of participants: 25

The topic of this workshop, held during the winter of 2004 at the Centre de recherches mathématiques, was the large N limit of Yang-Mills theory in dimension 2 and in related large N limits of matrix models. The subject was born in the observation of Gerard 't Hooft in 1972 that only planar Feynman diagrams survive the large N limit. This seems to indicate that the large N limit of gauge theory is a string theory. To a mathematician, this means that integrals over moduli spaces of $U(N)$ bundles over a Riemann surface have an asymptotic expansion in powers of N involving branched covers of the Riemann surface. Precise conjectures were formulated in the early 90's by D. J. Gross, W. Taylor, V. Kazakov, M. Douglas, G. Moore and others, largely based on exact formulae for the partition function by A. Migdal.

The workshop opened with a long talk by V. Kazakov on the background of the conjectures and some recent physical developments related to them. M. Douglas then lectured on his ideas relating large N limits to conformal field theories. For many in the audience, these talks were the foundations for their future discussions with the physicists. I. Kostov, and M. Staudacher gave more specialized talks on matrix models and gauge theories in the large N limit.

On the second day, N. Reshetikhin described his work with A. Okounkov and others on 3D Young diagrams, a kind of 3D analogue of the 2D large N limits. A. Okounkov then explained the background representation theory and probability theory. These lectures were masterful in their grasp of both the physical theories and the rigorous results related to them. S. Zelditch then presented rigorous results on the large N limits of partition functions and characters which contradicted the conjectures of D.J. Gross-A. Matytsin and of V. Kazakov-T. Wynter. Members of the audience suggested several explanations (not all consistent) on how to fix the conjectures. Later that day, C. Frohman explained an approach to the calculation of expected values of Wilson loop functionals and polynomials in Wilson loops, based on a diagrammatic approach to knots and links.

The third day was devoted to large deviations and statistical

mechanics. A. Guionnet and O. Zeitouni explained how large deviations theory proved the conjectures of Gross-Matytsin on spherical integrals and characters, once they were analytically continued to positive matrices. These positive results contrasted the counterexamples of Zelditch for large N asymptotics of characters on $U(N)$. Clearly, the conjectures were false in the oscillating regime and correct in the positive regime. Guionnet also explained relations to free probability which in principal 'solve' all random matrix models in the large N limit. P. Bleher surveyed his work on random matrix models. In the afternoon, M. Shcherbina explained her proof of the Douglas-Kazakov phase transition and also her results on spectral statistics of random matrix models. J. Harnad presented his results on random matrix models and bi-orthogonal polynomials. These were later followed by talks by his collaborators, Korotkin and Bertola on asymptotics of partition functions of matrix models.

The fourth day was largely devoted to the geometry of gauge theories. W. Goldman and R. Wentworth explained the Morse theory of the Yang-Mills functional. That led to C. Woodward's rigorous proof of the Migdal formula, based on a sum over critical points of the YM functional. Goldman's talk also provided background for the talk of F. Labourie on his important recent results on large N limits of moduli spaces of $SL(N, \mathbb{R})$ connections. His limit space bore an intriguing relation to the conformal field theory conjectured by M. Douglas many years ago, and it will be interesting to understand the relation further.

The audience was quite eclectic, ranging from physicists to analysts to probabilists to geometers to representation theorists. Nevertheless, the participants affirmed frequently and spontaneously that there was much fruitful discussion across boundaries. Certain members of the audience, e.g. A. Okounkov and M. Douglas, had a sure grasp of virtually every aspect of the conference and were very helpful in gluing together the disparate groups. For instance, A. Guionnet and O. Zeitouni could rigorously explain the 'saddle-point' arguments of the physicists from the viewpoint of large deviations, and A. Okounkov could explain the representation theory behind their views on large N limits.

Thus, in four short days, the conference succeeded in tying together numerous fuzzy threads in the literature and a variety of new projects were born.

For further details concerning the workshop, please log on the web site at www.crm.umontreal.ca/Gauge/

Workshop on spectral geometry

March 4-6, 2004

Org.: Iosif Polterovich (Montréal)

Speakers: Mark S. Ashbaugh (Missouri), Jean-Marc Bouclet (Lille 1), Maxim Braverman (Northeastern), Jochen Brüning (Humboldt), Zindine Djadli (Cergy-Pontoise), Leonid Friedlander (Arizona), Dmitri Gioev (Pennsylvania), Carolyn S. Gordon (Dartmouth College), Michael Hitrik (UCLA), Victor Ivrii (Toronto), Eran Makover (Connecticut College), Dan Mangoubi (Technion), Rafe Mazzeo (Stanford), Peter A. Perry (Kentucky), Steve Zelditch (Johns Hopkins).

Number of participants: 27

Posing the right question is sometimes more important in mathematics than finding the answer. It has been almost forty years since Mark Kac asked “Can one hear the shape of a drum?”, but the study of the interplay between the geometry and the spectrum remains as active as ever. Some recent developments in this field were discussed at the Workshop on Spectral Geometry, organized by Iosif Polterovich (Montréal).

AARMS-CRM - Workshop on singular integrals and analysis on CR manifolds

May 3-8, 2004, Halifax, Nova Scotia

Org.: Galia Dafni (Concordia), Andrea Fraser (Dalhousie)

Speakers: Shiferaw Berhanu (Temple), Albert Boggess (Texas A&M), Der-Chen Chang (Georgetown), Paulo Ciatti (Padova), Anthony Dooley (New South Wales), Wayne Eby (Temple), Gerald Folland (Washington), Simon Gindikin (Rutgers), Peter C. Greiner (Toronto), Jennifer Lynn Halfpap (Wisconsin-Madison), Adam Koranyi (CUNY Lehman College), Alexander Nagel (Wisconsin-Madison), Maria Roginskaya (Chalmers), Linda Rothschild (UC San Diego), Nancy Stanton (Notre Dame), Wolfgang Staubach (Fields), Keith F. Taylor (Dalhousie), Jingzhi Tie (Georgia), Dimitar Vassilev (CRM), James Wright (Edinburgh), Jie Xiao (Memorial).

Number of participants: 27

The theory of singular integral operators in the context of analysis on CR submanifolds of C^n , in particular the Heisenberg group, has been studied and proven fruitful over the last 30 years. In recent years, the emphasis has shifted to singular integral operators which do not fall under the standard Calderon-Zygmund theory. These include operators arising from product kernels on nilpotent Lie groups, which in turn lead to the study of flag kernels. The workshop brought together researchers from the areas of harmonic analysis, several complex variables, symmetric spaces and Lie groups.

The centerpiece of the conference was a series of five lectures delivered by Alexander Nagel (Wisconsin-Madison) and outlining his recent fundamental work on the following topics: the theory of product singular integrals on products of Carnot-Carathéodory spaces, flag kernels on homogeneous nilpotent Lie groups and applications to quadratic CR manifolds (joint with Fulvio Ricci and Elias M. Stein), the $\bar{\partial}$ -complex on decoupled domains (joint with Elias M. Stein), and the Bergman kernel for the “cross of iron” domain (joint with Malabika Pramanik).

The rest of the talks in the workshop concerned results that touched on these various topics and related subjects. Many participants commented on the fact that the conference was very focused and the speakers were all interested in each other’s talks. The half-hour talks by younger participants were also very appreciated and allowed the senior mathematicians to see what the new generation of mathematicians is working on. The atmosphere during the workshop was very convivial.

Workshop on spectral theory and automorphic forms

May 4-7, 2004

Org.: D. Jakobson (McGill), Y. Petridis (The Graduate Center and Lehman College, City University of New York)

Speakers: Andrew Booker (Paris-Sud), Gautam Chinta (Brown), Alina Carmen Cojocaru (Princeton), Eduardo Duenez (Johns Hopkins), Alexander Gamburd (Stanford), Dorian Goldfeld (Columbia), Gergely Harcos (Texas at Austin), Dennis A. Hejhal (Minnesota and Uppsala), Harald Helfgott (Yale), Lizhen Ji (Michigan), Chris Judge (Indiana), Habiba Kadiri (CRM), Emmanuel Kowalski (Bordeaux I), Jens Marklof (Bristol), Stephen David Miller (Rutgers), Steven J. Miller (Ohio State), Werner Müller (Bonn), Ram Murty (Queen’s), Cormac O’Sullivan (CUNY), Peter A. Perry (Kentucky), Andrei Reznikov (Weizmann Institute of Science), Guillaume Ricotta (Montpellier), Zeev Rudnick (Tel-Aviv), Peter Sarnak (Princeton), Richard Sharp (Manchester), Lior Silberman (Princeton), Morten Skarsholm Risager (Aarhus), Kannan Soundararajan (Michigan), Fredrik Stromberg (Uppsala), Akshay Venkatesh (MIT).

Number of participants: 52

The Conference coincided with the three lectures of Peter Sarnak, Chair Aisenstadt 2003-2004. While the first lecture was a general introduction on the Spectrum of the modular group, the subsequent lectures discussed latest results on quantum and classical fluctuations and lattice packing.

The participants included 10 of his 34 students. The overall level of the activity was extremely high. A number of the participants have been recently awarded various distinctions, e.g. A. Cojocaru and Nathan Ng have been awarded the Doctoral Prize of the Canadian Math Society (2003, 2001), K. Soundararajan is a Salem Prize Winner (2004), S. D. Miller is a Sloan Fellow (2003), A. Venkatesh is a Clay Research Fellow (2004), Z. Rudnick won the Erdos Prize 2001, R. Murty won the Jeffery-Williams prize 2003 and the Queen’s Research Prize 2003.

Topics debated were ranging from the computational aspects of Maass cusp forms to subconvexity problems for L-functions with applications to Quantum Ergodicity and Quantum Chaos, the problem of existence of cusp forms and Weyl’s Law, relations with dynamical systems and arithmetic, statistical behavior of zeros of L-functions and relation to the Riemann Hypothesis, multiple Dirichlet series etc.

Workshop on Integrable and Near-integrable Hamiltonian PDE

May 17-21, 2004

Org.: W. Craig (McMaster), P. Deift (Courant Inst.), S. Kuksin (Heriot-Watt), P. Olver (Minnesota), J. Toth (McGill), P. Winternitz (Montréal).

Speakers: Simonetta Abenda (Bologna), Dario Bambusi (Milano), Massimiliano Berti (SISSA, Trieste), Roy Choudhury (Central Florida), Percy Deift (CIMS), Hakan Eliasson (Paris VII), Benoît Grébert (Nantes), John Harnad (CRM & Concordia), Eduard-Wilhelm Kirr (Chicago), Sergei Kuksin (Heriot-Watt), Nader Masmoudi (CIMS), Maung Minoo (McMaster), N. Sri Namachchivaya (Illinois at Urbana-Champaign), Jürgen Pöschel (Stuttgart), David Sattinger (Yale), Michael Sigal (Notre Dame & Toronto), Vladimir Sokolov (Landau Institute), Jacek Szmigielski (Saskatchewan), Alexander Tovbis (Central Florida), Eugene Wayne (Boston), Stephanos Venakides (Duke), Vitali Vougalter (McMaster), Doug Wright (McMaster), Yingfei Yi (Georgia Institute of Technology), Jiagong You (Nanjing), Xin Zhou (Duke).

Among the topics that were discussed at the workshop were: KAM theory for PDE and other Hamiltonian systems possessing infinitely many degrees of freedom, Nekhoroshev stability theory and analogs of Arnold diffusion in infinite dimensional systems, extension of techniques of quadrature for integrable systems, including elements of inverse spectral theory and random matrix theory, and refined asymptotics of integrable systems in singular limits such as the small dispersion limit. This workshop was a part of the Fields Institute's year long program on partial differential equations, as well as being a cooperative effort with the CRM special year on Spectral analysis and geometry.

Workshop on Hamiltonian Dynamical systems (jointly with the Fields Institute)

May 24-28, 2004

Org.: Dario Bambusi (Milano), Walter Craig (McMaster), Sergei B. Kuksin (Heriot-Watt), C. Eugene Wayne, Chair (Boston) & Eduard Zehnder (ETH, Zurich).

Speakers: S. Bolotin (Wisconsin), C.-Q. Cheng (Nanjing), L. Chierchia (Roma Tre), R. de la Llave (Texas at Austin), D. Gaidashev (Toronto), V. Gelfreich (Warwick), G. Gentile (Roma Tre), V. Ginzburg (UC at Santa Cruz), D. Gomes (Berkeley), H. Hofer (Courant Institute), L. Jonsson (Fields Institute), T. Kappeler (Institut für Mathematik, Zürich), D. Khmelev (Toronto), M. Levi (Penn State), J. Mather (Princeton), K. Meyer (Cincinnati), D. Offin (Queen's), D. Sauzin (CNRS - Institut de Mécanique Céleste), L. Stolovitch (CNRS-Laboratoire Emile Picard), D. Treschev (Moscow State University), M. Yampolsky (Toronto), C. Zeng (Virginia).

Number of participants: 54

This workshop focused on analytic techniques of Hamiltonian dynamical systems, including perturbation theory, variational methods and stability theory. The subject includes both finite dimensional Hamiltonian systems such as in celestial mechanics, and infinite dimensional Hamiltonian systems, such as those arising from PDE or from other dynamical systems with infinitely many degrees of freedom.

This meeting was in fact a continuation of a regular series of workshops on analytic methods for Hamiltonian dynamical systems. This series was an outgrowth of the famous Oberwolfach workshops organized by J. Moser and E. Zehnder. The last two workshops took place at the International Centre for Mathematical Sciences in Edinburgh, at two year intervals of time.

Funding for these meetings has come from from the European Community, the EPSRC of Britain, the NSF Committee for International Programs, the Clay Mathematics Institute. The support for the CRM/Fields workshop on Hamiltonian dynamical systems came from the NSERC, the Fields Institute, the CRM and the Canada Research Chairs Program.

In particular, we planned a schedule similar to prior meetings, with only four to six talks per day which left plenty of time for interactions between the participants and informal discussions. Among the topics that were discussed at the workshop were drift and diffusion in Hamiltonian systems, KAM theory, applications of symplectic geometry to Hamiltonian dynamics and celestial mechanics.

A particular focus was the phenomenon of Arnold diffusion in which arbitrarily small perturbations of integrable Hamiltonian systems may result in instability of the system's trajectories. First described exactly 40 years ago by V.I. Arnold (Instability of dynamical systems with many degrees of freedom, Dokl. Akad. Nauk SSSR 156 1964) this phenomenon was understood for many years only in the context of certain special examples. In the last five or six years, however, a number of different approaches have begun to yield a more complete understanding of this basic property of Hamiltonian dynamics and many of the talks at this workshop were devoted to explicating the geometrical, variational and perturbative techniques that are needed to unravel this phenomenon. As its name suggests, there is a certain randomness in the trajectories that are observed in systems undergoing Arnold diffusion and some of the talks also discussed this relationship between the apparent unpredictability of these random motions and the determinism inherent in classical mechanical systems.

Another topic figuring in several talks was celestial mechanics. It was the study of planetary motion that led to the creation of Hamiltonian dynamics and the subject remains a source of interesting problems for the field. The talks on celestial mechanics ranged from the study of quasi-periodic motions in the solar system to studies of integral manifolds in the three-body problem; the techniques brought to bear on their solution, which ranged from the very analytical approach of the Kolmogorov-Arnold-Moser Theory to a topological investigation of the energy surfaces, illustrated how broad the mathematical underpinnings of Hamiltonian dynamics have become.

The mechanics of the workshop exhibited the close cooperation of the Fields Institute and the Centre de Recherches Mathématiques. Montréal was an ideal locale for the meeting, and we think that the CRM and the city made a lasting good impression on the workshop participants.

Workshop on semi-classical theory of eigenfunctions and PDEs

June 1-11, 2004

Org.: D. Jakobson (McGill), J. Toth (McGill)

Speakers: Ivana Alexandrova (California, Berkeley), Alex Barnett (Courant Institute), Marco Bertola (Concordia), Xu Bin (Tokyo Institute of Technology), Eugène Bogomolny (Paris-Sud), David Borthwick (Emory), Alain Bourget (McGill), Nicolas Burq (Paris-Sud), Yves Colin de Verdière (Grenoble I), Walter Craig (McMaster), Harold Donnelly (Purdue), Cristian Enache (Laval), Leonid Friedlander (Arizona), Patrick Gerard (Paris-Sud), Daniel Grieser (Bonn), Pengfei Guan (McMaster), Victor Guillemin (MIT), Eric Heller (Harvard), Luc Hillairet (École Normale Supérieure de Lyon), Alex Iantchenko (Malmö), Alexandru Ionescu (Wisconsin Madison), Victor Ivrii (Toronto), Chris Judge (Indiana), Shannon Lee Starr (CRM), Maung Min-Oo (McMaster), Nikolai Nadirashvili (Chicago), Fedor Nazarov (Michigan State), Yiannis N. Petridis (City Univ. of New York Lehman College), Vesselin Petkov (Bordeaux 1), Georgi Popov (Nantes), Yuri Safarov (King's College London), Mikhail Shubin (Northeastern), Alexander Sobolev (Sussex), Christopher Sogge (Johns Hopkins), Alexander Stohmaier (Bonn), Tatsuya Tate (Keio), Alejandro Uribe (Michigan), Andre Voros (CEA), Andre Voros (CEA-CENS), Steve Zelditch (Johns Hopkins), Maciek Zworski (Berkeley).

Number of participants: 51

The correspondence principle in quantum mechanics predicts that the behaviour of the high-energy eigenfunctions reflects the properties of the corresponding classical system – the geodesic flow. This was the central theme of the Workshop on Semi-Classical Theory of Eigenfunctions and PDEs, organized by Dmitry Jakobson and John Toth (McGill). In particular, the workshop focused on the phenomena of “scarring”: exceptional localization of the eigenfunctions around the periodic orbits of the classical flow. Scarring was the topic of the lectures of the physicists Eugene Bogomolny (Orsay) and Eric Heller (Harvard). Professor Heller, among other things, demonstrated that eigenfunctions belong not only to science, but also to art! His exhibition “Visions from the quantum frontier,” presented at the Centre d'exposition de l'Université de Montréal, featured a beautiful “portrait gallery” of eigenfunctions, created using numerical simulations of various quantum systems.

Workshop on spectral theory of Schrödinger operators

July 26-30, 2004

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

Speakers: Michael Aizenman (Princeton), Joseph Avron, Jean-Marie Barbaroux (Centre de Physique Théorique), Jonathan Breuer (Hebrew), Jean Michel Combes (Centre de physique théorique), Ovidiu Costin (Rutgers), Rafael del Rio (UNAM), Alexander Elgart (Stanford), Alexander Fedotov (Institute of Physics), Alexander Figotin (UC Irvine), Richard G. Froese (UBC), François Germinet (Cergy-Pontoise), Peter Hislop (Kentucky), Dirk Hundertmark (Illinois at Urbana-Champaign), Svetlana Jitomirskaya (UC Irvine), Alain Joye (Institut Fourier, Grenoble), Yulia Karpeshina (Alabama at Birmingham), Rowan Killip (UCLA), Werner Kirsch (Ruhr-Univ. Bochum), Alexander Kiselev (Wisconsin Madison), Abel Klein (UC Irvine), Frédéric Klopp (UMR – CRNSG), Ari Laptev (Royal Institute of Technology,

Stockholm), Daniel Lenz (TU Chemnitz), Peter Mueller (Goettingen), Yehuda Pinchover (Technion-Israel Institute of Technology), Joaquim Puig (Barcelona), Oleg Safronov (Alabama at Birmingham), Barry Simon (Caltech), Alexander Sobolev (Sussex), Peter Stollmann (TU Chemnitz), Gunter Stolz (Alabama at Birmingham), Yosef Strauss (Hebrew), Serguei Tcheremchantsev (Orléans), Boris Vainberg (UNC-Charlotte).

Number of participants: 77

The focus of this workshop was spectral theory of random and quasiperiodic Schrödinger operators. In solid state physics these operators serve as models of disordered systems, such as alloys, glasses and amorphous materials. The disorder of the system is reflected by the dependence of the potential on some random parameters.

The workshop has brought together the world leaders in spectral theory of random and quasi-periodic operators. The mini-courses were given by M. Aizenman (Princeton), who spoke on spin-glass systems and recent spectacular resolution of Parisi conjecture by Talagrand, by B. Simon (Caltech), who spoke on the spectral theory of orthogonal polynomials, and S. Jitomirskaya (Irvine), who spoke on the recent spectacular resolution of the final part of the celebrated Mark Kac “Ten Martini Problem”. The resolution of the “Ten Martini Problem” took over two decades, and practically all major contributors were in the audience. After Jitomirskaya’s lecture, M. Aizenman, the editor of “Communications in Mathematical Physics,” has awarded silver olives to the present contributors.

The workshop had a heavy schedule---besides three two-hours mini-courses, there were thirty two half hour lectures. The quality of the talks, the attendance and the atmosphere were extraordinary.

A particularly noticeable was a number of young people---starting with Joaquim Puiq, who was then still a graduate student (and who completed the “Ten Martini Problem”) and ending with a number of first year graduate students who got their first exposition to the field on this conference.

The general feeling among senior participants about the conference was very positive. A number of them thought that in the terms of the scientific impact and quality of the organization this was the best conferences in spectral theory of Schrödinger operators in the last twenty years.

Workshop on dynamics in statistical mechanics

August 2-6, 2004

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

Speakers: H. Araki (Kyoto), J. Bellissard (Atlanta), P. Blanchard (Bielefeld), L. Bruneau (Warsaw), T. Chen (Courant), S. De Bievre (Lille), J. Dereziński (Warsaw), B. Derrida (Paris), J.-P. Eckmann (Geneva), G. Elliott (Toronto), A.C. D van Enter (Groningen), L. Erdős (München), B. Helffer (Paris), G.-M. Graf (ETH), M. Griesemer (Alabama), C. Jäkel

(Münich), G. Jona-Lasinio (Rome), A. Knauf (Erlangen), R. Livi (Florence), M. Merkli (Montreal), T. Matsui (Kyushu), B. Nachtergaele (Davies), K. Netocny (Groningen), F. Nier (Rennes), Y. Ogata (Tokyo), Y. Pautrat (Montreal), L. Rey-Bellet (Amherst), R. Seiringer (Princeton), D. Spehner (Essen), S. Starr (Montreal), L. Thomas (Virginia), A. Verbeure (Leuven), H.T. Yau (Stanford), L.-S. Young (Courant), V. Zagrebnov (Marseille).

Number of participants: 70

This workshop was devoted to the study of dynamical properties of (classical and quantum) open systems with particular emphasis on the recent developments in non-equilibrium statistical mechanics. In recent years, through the study of noisy or forced dissipative systems, or Hamiltonian systems with a large number of degrees of freedom, our understanding of the mathematical structure of nonequilibrium statistical mechanics has greatly improved. The aim of this meeting was to present the latest results and discuss the possible future directions of research in this area.

The mini-courses were given by B. Derrida (École Normale), who gave an introduction to surprising new variational principles in classical non-equilibrium statistical mechanics (these results were further elaborated in the talk of G. Jona-Lasinio), by H. Araki (Kyoto), who reviewed the recent work on Gibbs variational principle for interacting quantum fermionic systems, by J-P. Eckmann (Geneva), who spoke on the fundamental open problem of derivation of macroscopic Fourier law for heat conductance from microscopic Hamiltonian dynamics (and its resolution for a toy model of Eckmann-Young), and by L. Erdos (Munich), who spoke on spectacular recent progress in the study of hydrodynamical limits.

An important aspect of the conference was the variety of topics covered, all of which had a relation (sometimes surprising) with the main theme. For example, F. Nier's talk on semiclassical analysis of low-lying eigenvalues of Witten Laplacians was closely related to the study of non-equilibrium steady states of classical open system by Eckmann-Pillet-Bellet. The other topics ranged from spin systems (Matsui, Nachtergaele, Starr) to quantum field theory (Derezinski, Jakel, Bruneau).

The Friday afternoon section was devoted to talks of young researchers (mainly postdocs)--Bruneau, Merkli, Ogata (who was still a graduate student), Pautrat and Netocny. These talks confirmed that the future of this difficult and fundamental field, which goes back to fundamental work of Boltzmann and Gibbs, and which still causes sometimes the controversies in scientific circles, is in good hands.

Compared with recent major workshop at CIRM, Marseille (held in March 2003), practically all participants were surprised how many novel results have been obtained in a short span of one year and a half.

The field of non-equilibrium statistical mechanics has staged a spectacular progress in the last decade, and this workshop was a very important snapshot of its development. Just like the CIRM

workshop, we are confident that the CRM workshop will also lead to major new developments. We expect to see some of them at the next major workshop---a two month (Jan-March 2005) program on "Open Systems" in "Schrodinger Institute" in Vienna (organized by Derezinski, Graf, Yngvanson).

Exposition Heller

À l'occasion du 125^e anniversaire de l'Université de Montréal, le CRM a présenté, du 13 mai au 1^{er} juin 2004, une exposition d'une trentaine d'oeuvres d'Eric J. Heller au Centre d'exposition de l'Université. Cette exposition, qui s'intitulait « Aux confins de l'univers quantique », fut également présentée pendant quelques semaines au Centre des sciences du Vieux-Port de Montréal.

Le professeur Heller, qui partage son temps entre les Départements de physique et de chimie de l'Université Harvard, étudie le monde quantique des molécules, des atomes et des électrons en effectuant des simulations numériques sur ordinateur. Depuis le milieu des années 80, il crée des oeuvres d'art à partir de graphiques tirés de ces simulations. Ses oeuvres, qui évoquent les mystères de l'univers quantique, ont vite connu une très vaste diffusion tant dans les centres d'exposition que dans la presse.

Deux conférences publiques soulignèrent cette exposition. Le 13 mai, Jean LeTourneur, directeur adjoint du CRM, parla de « La science derrière les oeuvres d'Eric Heller », et le 1^{er} juin, le professeur Heller, après avoir prononcé la conférence d'ouverture de l'atelier sur la théorie semi-classique des fonctions propres et équations aux dérivées partielles, présenta au Centre d'exposition un exposé intitulé « Art, Science and Politics ».

Past Thematic Programs

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

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

2002-2003	Math in Computer Science
2001-2002	Groups and Geometry
2000-2001	Mathematical Methods in Biology and Medicine
1999-2000	Mathematical Physics
1998-1999	Number Theory and Arithmetic Geometry
1997-1998	Statistics
1996-1997	Combinatorics and Group Theory
1995-1996	Applied and Numerical Analysis
1994-1995	Geometry and Topology
1993-1994	Dynamical Systems and Applications
1992	Probability and Stochastic Control (special semester)
1991-1992	Automorphic Forms in Number Theory
1991	Operator Algebras (special semester)
1990	Nonlinear PDE's and Applications (focal period)
1988	Shimura Varieties (special semester)
1987	Quantum Field Theory (special semester)
1987-1988	Fractals: Theory and application
1987	Structural Rigidity (special semester)

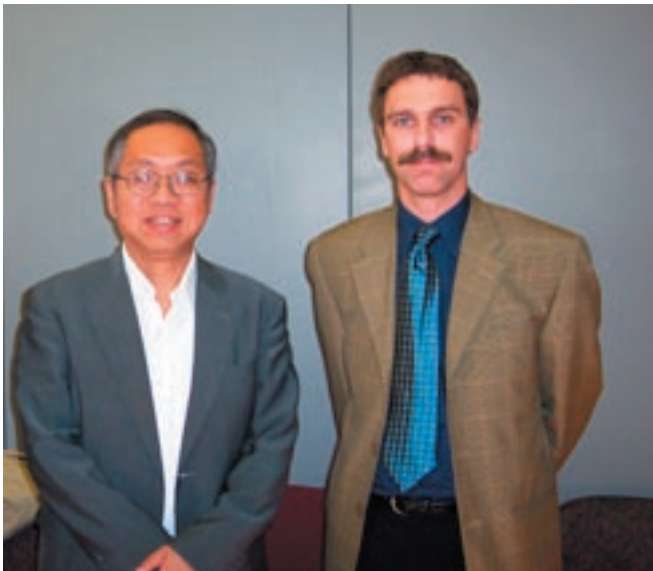
Aisenstadt Chairholders in 2003-2004: S.T. Yau and P. Sarnak

The Aisenstadt Chair was endowed by Montréal philanthropist Dr. André Aisenstadt. Under its auspices, one or more distinguished mathematicians are invited each year for a period of at least one week, ideally one or two months. During their stay the lecturers present a series of lectures on a specialized subject. They are also invited to prepare a monograph (see the Publications section in this report for a list of these publications). At the request of Dr. Aisenstadt, the first of their lectures should be accessible to a wide audience. Previous holders of the Aisenstadt Chair are: Marc Kac, Eduardo Zarantonello, Robert Hermann, Marcos Moshinsky, Sybren de Groot, Donald Knuth, Jacques-Louis Lions, R. Tyrell Rockafellar, Yuval Ne'eman, Gian-Carlo Rota, Laurent Schwartz, Gérard Debreu, Philip Holmes, Ronald Graham, Robert Langlands, Yuri Manin, Jerrold Marsden, Dan Voiculescu, James Arthur, Eugene B. Dynkin, David P. Ruelle, Robert Bryant, Blaine Lawson, Yves Meyer, Ioannis Karatzas, László Babai, Efim I. Zelmanov, Peter Hall, David Cox, Frans Oort, Joel S. Feldman, Roman Jackiw, Duong H. Phong, Michael S. Waterman, Arthur T. Winfree, Edward Frenkel, Laurent Lafforgue, George Lusztig, László Lovász and Endre Szemerédi.

The CRM was honoured to have as Aisenstadt chairholders, during the 2003-2004 theme year Geometric and Spectral Analysis, Professors Shing-Tung Yau of Harvard University and Peter Sarnak of Courant Institute.

Shing-Tung Yau

Professor Yau obtained his Ph.D. in Mathematics from the University of California at Berkeley in 1971, under Professor Chern's supervision. After spending a year at the Institute for Advanced Study, he taught successively at S.U.N.Y. Stony Brook, at Stanford University, at the Institute for Advanced Study, at the University of California at San Diego, and at the University of Texas at Austin. In 1987 he was appointed Professor of Mathematics at Harvard University, a position he has held ever since.



Professor Yau with CRM Acting Director Christian Léger..



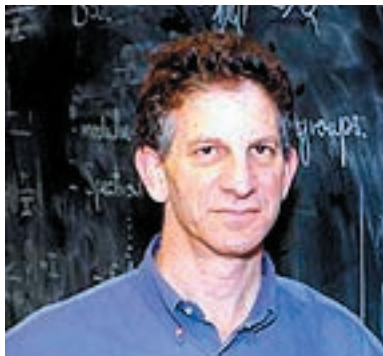
Professor Yau lecturing at CRM in October 2003..

His fields of research are differential geometry, differential equations and general relativity. He has received the highest awards for his outstanding contributions. Besides the Fields Medal (1982), he was awarded the Veblen Prize (1981), the Carty Prize of the National Academy (1981), the Crafoord Prize of the Royal Swedish Academy (1994), and the National Medal of Science, U.S.A. (1997). In 1979, he was elected California Scientist of the year. He is a member of the American Academy of Arts and Sciences, or the Chinese Academy of Sciences, of the Academia Sinica, and of the Russian Academy of Sciences. He has received four honorary doctorates and he is an honorary professor of many universities.

Chaire Aisenstadt - continued

Peter Sarnak

Professor Sarnak was born in Johannesburg, South Africa in 1953. He obtained his bachelors degree from University of Witwatersrand in 1975 and his Ph.D. from Stanford University in 1980.



He joined the Courant Institute as an assistant professor in 1980, becoming an associate professor in 1983. He moved to Stanford University as a Professor in 1987. In 1989 he was the Sherman Fairchild Distinguished scholar at Caltech. Since 1991 he has been a professor of mathematics at Princeton University. There

he was the H. Fine Professor from 1995-6, Department Chair from 1996-9 and since 2002 is the Eugene Higgins Professor of Mathematics. Between 1999 and 2002 he was a member of the Institute for Advanced Study at Princeton, and since 2001 he is also a Professor of Mathematics at the Courant Institute.

Professor Sarnak has received numerous awards and honours including being a Sloan Fellow (1983-5) and a Presidential Young Investigator (1985-90). He was awarded the Polya Prize by SIAM in 1998, the Ostrowski prize from the Ostrowski Foundation in 2001 and the Levi L. Conant Prize of AMS in 2003. He was elected to the American Academy of Arts and Sciences in 1991 and both as a member of the National Academy of Sciences (USA) and as a Fellow of the Royal Society (UK) in 2002.

He has published more than 90 academic journal papers, and written several books, and edited several more, as well as supervising more than thirty (thirty two at last count) PhD students.

His main interests are in the theory of zeta functions with applications to number theory, mathematical physics and automorphic forms. His citation on election to the Royal Society states that he is "distinguished for his major contributions to analysis and number theory. He is widely recognised internationally as one of the leading analytic number theorists of his generation. His early work on the existence of cusp forms led to the disproof of a conjecture of Selberg. He has obtained the strongest known bounds towards the Ramanujan conjectures for sparse graphs and he was one of the first to exploit connections between certain questions in theoretical physics and analytic number theory."



Peter Sarnak.

General Program 2003-2004

The CRM's general program funds a wide variety of scientific events, both on-site, elsewhere in Canada 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 program promotes research in the mathematical sciences at all levels. The program is quite flexible, allowing projects to be considered as they arise. *The reports are presented in the language in which they were submitted.*

Séminaire de Mathématiques Supérieures: Structural Theory of Automata, Semigroups, and Universal Algebra

July 7-18, 2003

Org.: Ivo Rosenberg, (Montréal), Valeriy Kudryavtsev, (Moscow State).

Speakers: Jorge Almeida (Porto), Joel Berman (Illinois at Chicago), Jürgen Dassow (Magdeburg), Rusins Freivalds (Latvia), Andrei Krokhnin (Warwick), Alexander Letichevsky (Glushkov Institute of Cybernetics, NAS Kiev, Ukraine), Ralph McKenzie (Vanderbilt), Ivo Rosenberg (Montréal), Lev N. Shevrin (Ural State Univ.), Magnus Steinby (Turku), Mikhail Volkov (Ural State Univ.).

The lectures at this NATO Advanced Study Institute covered a wide range of the theory of automata, semigroup theory and universal algebra. The topics of the lectures mostly related at least two of the three fields, used concepts and techniques from other domains and showed some intrinsic connections.

Structural theory of automata

Two of the courses were concerned with problems arising from the construction – via composition and feedback – of new automata from a given set of automata over the same input and output alphabets. A basic problem is to find a completeness criterion. In the feedback-free case, the question of uniformly delayed completeness, requiring complex universal algebra and relational tools, was addressed by Rosenberg. Variants of the general problem induced by certain equivalence relations were discussed by Dassow. A correspondence between varieties of finite algebras and varieties of tree languages was presented by Steinby. Finite quantum automata – a close counterpart of probabilistic finite automata – and the combinatorial problems related to recognizability of languages were presented by Freivalds. The behaviour of the general interaction of agents and environments were considered by Letichevsky.

Semigroups

The lectures dealt with fundamental results often connected to the other two topics. Profinite semigroups, presented by Almeida, use algebraic and topological methods and serve for classifying rational languages. Automata, algorithmic and complexity-theoretical aspects of semigroup varieties (Volkov) relate semigroups and computer science. Epigroups, a large, rich and interesting class of semigroups, were presented by Shevrin.

Universal algebra

An important problem that appears in computer science, operations research, data bases and combinatorics is the so-called constraint satisfaction problem. An algebraic approach to it, based on clones and relations, and the computational complexity aspects, was presented by Krokhnin. The sizes of finitely generated free algebras in a locally finite variety form an important structural invariant of the variety. Their covers were discussed by Berman. Congruence modular varieties include groups, rings, modules and lattices. The commutator theory, a basic tool for the study of such varieties, was presented by McKenzie.

In addition to the main lecture series there were five one-hour presentations on topics related to the main lectures: varieties arising from finite languages, endoprimal algebras in certain varieties, syntactic congruences, topological quasivarieties, and counting problems for certain types of algebras.

Workshop on Algebraic Structures and Moduli Spaces

July 14-20, 2003

Org.: Eyal Markman (Massachusetts), Hiraku Nakajima (Kyoto).

Speakers: Claudio Bartocci (Univ. degli Studi di Genova), Alexander Braverman (Harvard), Jim Bryan (UBC), Andrei Caldararu (Pennsylvania), Linda Chen (Columbia), Mark de Cataldo (SUNY at Stony Brook), Kenji Fukaya (Kyoto), Victor Ginzburg (Univ. of California at Santa Cruz), Jacques Hurtubise (McGill), Hiroshi Iritani (Kyoto), Lisa Jeffrey (Toronto), Dmitry Kaledin (Independent Univ. of Moscow), Manfred Lehn (Johannes Gutenberg - Univ. Mainz), Yoshinori Namikawa (Kyoto), Keiji Oguiso (Tokyo), Justin Sawon (SUNY at Stony Brook), Michael Thaddeus (Columbia), Ravi Vakil (Stanford), Misha Verbitsky (Glasgow), Weiqiang Wang (Virginia), Kota Yoshioka (Kobe).

Number of participants: 43

One of the most fruitful interactions of modern mathematics has been the interplay between geometry and algebra; one simply has to think of the role homogeneous spaces have played in illuminating and expanding various concepts of representation theory. Conversely, a good algebraic action is often the key to understanding the geometry and the topology of a geometrical object. This was the central theme of a conference on Algebraic Structures and Moduli Spaces held at the CRM from July 14-20, 2003.

Hidden Algebraic Structure

The usefulness of uncovering “hidden” algebraic structure in the topology of various spaces is of course not new. An early manifestation of this was the Lefschetz decomposition theorem of Kähler geometry. A Kähler structure on a compact complex manifold is determined by a closed two-form on the manifold with certain properties. The operations of taking exterior product with this two form and of contracting by the same two-form define an action of the Lie algebra of $\mathfrak{sl}(2, \mathbb{C})$ on the harmonic forms on the manifold, and so on the cohomology. Decomposing the cohomology into irreducible representations gives a lot of information on the structure of the manifold. Another example of a truly intricate algebraic structure, of a more topological nature, has its origins in the study of the space $\text{Map}^*(S_n, X)$ of based maps from the n -sphere S_n into a space X . The space of maps is tied to configurations of points in the n -plane, and one obtains an intricate algebra of operations on the homology of this space in terms of natural operations on points in the plane. This algebraic structure and others like it were formalised into what is called an operad, and twenty years later, it was realised that this structure had important applications in the understanding of moduli spaces.

Fundamental Objects

These moduli spaces are fundamental objects in algebraic geometry and differential geometry. They parametrise geometric objects of a given type; one speaks, for example, of the moduli space of curves, or the moduli space of holomorphic vector bundles on a manifold, or of the moduli of instantons on a four manifold. These spaces have a remarkably beautiful structure in their own right; they also yield deep and detailed information on the base space over which they are defined: for example, the instantons over a four-manifold Y are remarkably fine tools for studying Y , or the holomorphic and pseudo-holomorphic maps from a Riemann surface into a holomorphic or symplectic manifold Z give us detailed invariants of the structure. Moduli spaces also have a remarkable habit of popping up all over the place in physics, and physicists have been at the origin of an astounding variety of deep conjectures on these spaces.

Nakajima and Grojnowski discoveries

At the conference, one example that was the subject of a beautiful four-hour series of talks by M. Lehn was the Hilbert scheme $\text{Hilb}^n(X)$ of n points on a complex surface X . This variety parametrises 0-dimensional subschemes of X of length n ; the generic element of $\text{Hilb}^n(X)$ corresponds to n unordered distinct points of X ; when the points collide, $\text{Hilb}^n(X)$ in some sense remembers some information about the way they did it. There are natural subvarieties of $\text{Hilb}^n(X) \times X \times \text{Hilb}^m(X)$ which can be used to define operations on the cohomology of the union of these schemes; it was the discovery of Nakajima and Grojnowski that these operations define an action of an infinite dimensional Heisenberg algebra on the cohomology. An extension of this representation to a larger vertex algebra, explains much of the structure of the cohomology rings of the Hilbert schemes. This, and further developments, were explained by Lehn. In a separate lecture, W. Wang related the tau-function of the 2-Toda

hierarchy to a generating function, arising from the equivariant cohomology of Hilbert schemes of points in the affine plane.

Remarkable conjectures by Nekrasov

In another vein, H. Nakajima and K. Yoshioka gave another very stimulating four hour series of talks on instanton counting on blow-ups. There are some remarkable conjectures by Nekrasov relating Seiberg-Witten prepotentials for supersymmetric gauge theories to integrals over the moduli space of instantons; the lecturers explained their proof of this conjecture using the relations between torsion free sheaves on a blow-up of \mathbb{P}^2 and on \mathbb{P}^2 . A. Braverman, later in the conference, gave his own constructions on a related moduli space, tying these integrals to intersection cohomology on a suitable compactification. The talks covered many aspects of the structure of moduli spaces and the invariants obtained from them: Gromov-Witten invariants and stable maps (J. Bryan, M. Thaddeus), Floer homology (K. Fukaya, H. Iritani), Hochschild cohomology and orbifold cohomology (A. Caldararu, L. Chen, D. Kaledin), Fourier-Mukai and Nahm-Fourier transforms (C. Bartocci, Y. Namikawa, J. Sawon), links to representation theory (V. Ginzburg, L. Jeffrey, R. Vakil). One of the basic cases for testing various aspects of the theory is the moduli space of K3 surfaces, and these surfaces were a substantial feature of several of the talks, notably those of K. Oguiso and M. Verbitski. The Lefschetz theorem, while several decades old, resurfaced in a recent version during the conference in a talk by M. de Cataldo. The workshop was held over a full week, with four hours of lectures per day and a long break at lunch for discussion. The fourth day was held at McGill’s Gault estate at Mont Saint-Hilaire, a beautiful forested location by a lake; after a morning session, the group adjourned for a walk in the woods. All made it back to the bus that afternoon, bringing with them, it is hoped, a few additional theorems. These, and an account of the talks at the conference, have appeared in CRM Proceedings and Lecture Notes.

61^e Colloque des Sciences Mathématiques du Québec

April 24, 2004

Plenary Speakers: Fahima Nekka (Montréal), Jiri Patera (Montréal) and Tom Ransford (Laval)

Number of participants: 50

Quatre ateliers ont été organisés. En voici la liste ainsi que les conférenciers pertinents:

Physique Mathématique

Org.: Piergiulio Tempesta (CRM)

Speakers: Alexander Hariton (Montréal), Marco Merkli (McGill), Vasilija Shramchenko (Concordia), Libor Snohl (CRM), Shannon Starr (CRM), Piergiulio Tempesta (CRM).

Analyse

Org.: Matthias Neufang (Carleton)

Speakers: Remus Floricel (Ottawa), Cristian Ivanescu (Toronto), Isidore Fleischer (CRM), Benjamin Itza-Ortiz (Ottawa), Claus Koestler (Queens).

Algèbre

Org.: Ibrahim Assem (Sherbrooke)

Speakers: Jessica Lévesque (Sherbrooke), David Smith (Sherbrooke), Jennifer Bélanger (Sherbrooke), Marcelo Lanzilotta (Republica), Julie Dionne (Sherbrooke).

Communications libres

Org.: Alain Rémillard (Montréal)

Speakers: Jacques Labelle (UQAM), Luc Bélaïr (UQAM), Michel Valley (Laval), Constantin Costara (Laval), Claudius Liviu Todor (Montréal).

Graphes et leurs cycles (Bondy et Fleischner ont 60 ans)

May 10-14, 2004

Org.: Gena Hahn (Montréal), Gert Sabidussi (Montréal)

Number of participants: 22

Colloque en l'honneur des soixante ans de J. A. Bondy et H. Fleischner, spécialistes en théorie des graphes en général et de la problématique des cycles dans des graphes en particulier. Le livre de Bondy et Murty est un des plus utilisé pour enseigner la théorie des graphes.

Les organisateurs ont laissé beaucoup de temps pour des discussions, chose bien appréciée. En effet, beaucoup de participants ont exprimé à plusieurs reprises leur satisfaction du format et du contenu du colloque.

Les conférences étaient de très bon niveau et rendaient hommage aux travaux des deux invités d'honneur, comme la renommée internationale de la majorité des conférenciers le laissait espérer. Le colloque était financé par des frais d'inscription et soutenu par le CRM qui a fourni la salle de conférence, l'accès internet aux participants ainsi qu'un soutien matériel et qui a contribué aux frais de voyage de H. Fleischner.

Interdisciplinary and Industrial Program

Summer School: The Mathematics of Bioinformatics

August 27-29, 2003, Univ. de Montréal

Org.: Nadia El-Mabrouk (Montréal), David Sankoff (Ottawa).

Speakers: Anne Bergeron (UQAM), Guillaume Bourque (CRM), David Bryant (McGill), Miklós Csürös (Montréal), Nadia El-Mabrouk (Montréal), Mike Hallett (McGill), Jotun Hein (Oxford), John Kececioglu (Arizona), Mathieu Raffinot (Evry), David Sankoff (Ottawa).

Number of participants: 105

L'objectif de cette école était d'introduire l'auditoire aux divers domaines de la bioinformatique, en favorisant des exposés pédagogiques clairs, qui introduisent le domaine avant de rentrer dans des aspects de recherche plus pointus. Cet esprit a été parfaitement respecté. En 1h30, le présentateur avait le temps de faire une bonne introduction au domaine, avant de parler de ses recherches propres. Plusieurs retours positifs sur l'école ont été reçus, en particulier de la part de professeurs de divers départements et de diverses universités (Canada et États-Unis) qui souhaitaient initier des formations en bioinformatique dans leurs départements, et qui trouvaient, dans cette école, toute la matière pour monter un cours. À la suite d'un grand nombre de demandes, il a été décidé de rendre disponibles tous les documents pertinents et les présentations des chercheurs sur la page web de l'école.

Dependence Modeling: Statistical Theory and Applications in Finance and Insurance

May 20-22, 2004, Château Laurier, Québec

Org.: Michel Gendron (Laval), Christian Genest (Laval), Étienne Marceau (Laval), Louis-Paul Rivest (Laval).

Speakers: B. C. Arnold (Riverside), M. Denuit (Univ. catholique de Louvain), P. Embrechts (ETH Zürich), K. Ghoudi (United Arab Emirates), H. Joe (UBC), É. Marceau (Laval), R. B. Nelsen (Lewis and Clark College), D. Oakes (Rochester), M. Scarsini (Torino).

Supported by: CRM, MITACS, Institut de finance mathématique de Montréal, Université Laval.

Number of participants: 111

This international meeting was intended as a sequel to the series of conferences on copulas and their applications that were held in Rome (1990), Seattle (1993), Prague (1996) and Barcelona (2000). The meeting took place at the Château Laurier, near Québec City's historical district, from Thursday, May 20, to Saturday, May 22, 2004.

As in previous editions, the meeting attracted copula specialists and statistical researchers interested in their development and use in characterizing and modeling dependence (stochastic orderings, distributions with fixed margins, etc.). As suggested by the title of the event, however, the meeting provided special emphasis on inferential aspects surrounding the use of copulas, and gave high visibility to their applications in actuarial science and finance.

Dependence issues and their treatment in survival analysis, extreme-value theory and hydrology were also central to the theme of the conference.

The keynote address, with historical overtones, was given by Prof. R. B. Nelsen, who is the author of a well known monograph on modeling dependence through copulas. Other plenary lectures were given by the invited speakers listed above. Each one, 45 minutes in length, surveyed major methodological developments on a specific aspect of the theory (concepts, methods, models, estimation, tests, etc.) and gave broad overviews of recent areas of application. Prof. Embrechts' lecture, delivered on Friday morning, was particularly lively and appreciated by the audience. Over 55 contributed talks, each 20 minutes in length, were also presented by participants from 18 different countries. Contributors were affiliated mostly with universities and research institutes, but actuarial firms, banks, and government departments or agencies were also well represented in the audience.

The main highlight of the cultural program was a field trip to Montmorency falls, on late Friday afternoon. This was followed by a four-course dinner at the Manor, located at the top of the falls, and by an excellent introduction to French Canadian musical traditions by renowned Quebec folk singer Yves Lambert and three musicians. Participants had plenty of opportunities to mingle at that event, as well as in between sessions or at night in parks, museums and restaurants located nearby the conference hotel, where nearly everyone stayed.

The conference was generally regarded as highly successful, both from a professional and a social perspective. Added visibility will be conferred to the event through the publication of peer-reviewed proceedings in the form of special issues of *The Canadian Journal of Statistics/La revue canadienne de statistique* (CJS) and *Insurance: Mathematics and Economics* (IME). In total, 29 manuscripts were submitted to these two issues, currently expected to be published in June, 2005. The IME issue will be edited by C. Genest, with the help of the three other organizers listed above. Genest will also serve as Editor for the CJS issue, with his colleague L.-P. Rivest, as well as H. Joe (UBC) and HEC Professors D. Dupuis and B. Rémillard serving as Associate Editors.

Joint Institute Initiatives

Certain activities of Canadian societies in the mathematical sciences are jointly sponsored by the Fields Institute, the Centre de recherches mathématiques, the Pacific Institute for the Mathematical Sciences, and in some cases by MITACS.

CMS Summer Meeting 2003

June 14–16, 2003

University of Alberta

Meeting Director: YanPing Lin (Alberta).

The 2003 CMS Summer Meeting was held at the University of Alberta on June 14-16, 2003, and welcomed 348 participants. The meeting began with Robert Moody (Alberta) delivering a Public Lecture entitled *Tilings: an evening excursion to the zoo*. The event, held at the Telus Center, drew a large audience and was followed by a welcoming reception.

Other special events included plenary talks delivered by: Ingrid Daubechies (Princeton), Roland Glowinski (Houston), Gerhard Huisken (Tuebingen/Albert Einstein Institute), James Lepowsky (Rutgers), & Dennis Shasha (Courant Institute).

The Canadian Mathematical Society was pleased to present lectures from their research prize winners, specifically, the CMS Jeffery-Williams Lecture, given by Ram Murty (Queen's) and the CMS Krieger-Nelson Lecture, given by Leah Keshet (British Columbia).

A wide variety of fields of interest were represented in the symposia topics detailed belows:

Algebraic and Geometric Topology, George Peschke (Alberta), Laura Scull (British Columbia) & Peter Zvengrowski (Calgary).

Approximation Theory and Applied Harmonic Analysis, Bin Han & Rong-Qing Jia (Alberta).

Computational and Analytical Techniques in Modern Applications, Peter Minev (Alberta).

Conformal Field Theory, Terry Gannon (Alberta) & Mark Walton (Lethbridge).

Design Theory and Coding Theory, John van Rees (Manitoba).

Discrete Mathematics, Vaclav Linek (Winnipeg).

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

Industrial Mathematics, Biao Huang, Yanping Lin & Shijie Liu (Alberta).

Infinite Dimensional Dynamical Systems, Thomas Hillen (Alberta) & XiaoQiang Zhao (Memorial Univ. of Newfoundland).

Mathematical and Computational Finance, Tahir Choulli & Jie Xiong (Alberta).

New and Successful Courses and Programmes in Mathematics, Ted Lewis (Alberta).

Physics and Geometry, Maung Min-Oo (McMaster) & Eric Woolgar (Alberta)

Real Analysis, Erik Talvila (Alberta).

The Meeting Committee would like to acknowledge with much thanks the financial support of the following: The National Programme Committee (a joint funding body of the Centre de recherches mathématiques, The Fields Institute for Research in Mathematical Sciences, and The Pacific Institute for the Mathematical Sciences), University of Alberta, Department of Mathematical and Statistical Sciences, Conference Fund, Faculty of Science & Theoretical Physics Institute, Applied Mathematics Institute; University of British Columbia Faculty of Science & Mathematics Dept; University of Lethbridge; Perimeter Institute for Theoretical Physics; Canadian Institute for Theoretical Astrophysics & Nelson, A Thomson Company.

CMS Winter Meeting 2003

December 6–8, 2003

Held at the Harbour Centre Campus
of Simon Fraser University

Org.: Meeting Director, Norman R. Reilly (SFU); Alastair Lachlan and Malgorzata Dubiel (SFU).

Special sessions:

Combinatorics, Petr Lisonek (SFU) & Brett Stevens (Carleton).

Dynamical Systems & Celestial Mechanics, Florin Diacu (UVIC).

Graphs and Matroids, Luis Goddyn (SFU) & Ladislav Stacho (SFU).

Harmonic Analysis, Izabella Laba (UBC) & Alex Iosevich (Missouri, Columbia).

History of Mathematics, J.Len Berggren (SFU).

Mathematical Biology, Leah Keshet (UBC).

Mathematical Education, Malgorzata Dubiel (SFU).

Model Theory and Recursion Theory, Robert Woodrow (Calgary) & Bradd Hart (McMaster).

Nonlinear Partial Differential Equations, Keith Promislow (SFU) & Rustum Choksi (SFU).

Number Theory, Michael Bennett (UBC), David Boyd (UBC), Peter Borwein (SFU), Imin Chen (SFU) & Stephen Choi (SFU).

Operator Algebras, Ian Putnam (UVIC) & Marcelo Laca (UVIC).

Quantum Cohomology and Mirror Symmetry, Kai Behrend (UBC).

Representations of Associative Algebras, Vlastimil Dlab (Carleton) & Shiping Liu (Sherbrooke).

Universal Algebra and Lattice Theory, Jennifer Hyndman (UNBC).

Plenary Speakers:

Tom Archibald (Acadia)

France, Germany, and the making of modern mathematics

Deborah Ball & Hyman Bass (Michigan)

The role of definitions in teaching and learning mathematics

Robert Calderbank (Princeton)

Quantum computers and cellular phones

Andrew Granville (Montréal)

Uncertainty principles in arithmetic

Anand Pillay (UIUC)

Stable theories, examples, and applications

Madhu Sudan (Radcliffe Institute for Advanced Study)

List decoding of error correcting codes

Coxeter-James Lecture

Jingyi Chen (UBC)

Recent developments in mean curvature flow of higher codimension

CMS Doctoral Prize Lecture

Alina Carmen Cojocaru (Princeton)

Elliptic curves modulo p

Short-course on Cryptography:

Neal Koblitz (Washington)

Introduction to elliptic curve cryptography

Mike Mosca (Waterloo)

Quantum computing and quantum cryptography

Doug Stinson (Waterloo)

Introduction to cryptography

Hugh Williams (Calgary)

Cryptography and number theory

The meeting was sponsored by the CMS, the National Program Committee (CRM, Fields, PIMS), Simon Fraser University, University of British Columbia, University of Calgary Department of Mathematics, University of Calgary Dean of Science, University of Northern British Columbia.

Annual Meeting of the Statistical Society of Canada (SSC)

May 30 to June 2, 2004, CRM, Université de Montréal

Organizers: Program Committee Chair, Christian Genest (Laval);

Local Arrangements Chair, Christian Léger (Montréal)

The thirty-second annual meeting of the Statistical Society of Canada was hosted by the Université de Montréal, and the Centre de recherches mathématiques. Over 550 registrants participated

in the meeting, which featured a wide range of sessions, including workshops of three SSC sections: Biostatistics, Survey Methods, and Business and Industrial Statistics.

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

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

Presidential Invited Address:

Kathryn Roeder (Carnegie Mellon)

Discovering haplotype blocks in the human genome

Gold Medal Address:

Mary Thompson (Waterloo)

Understanding associations: implications for the design and analysis of longitudinal surveys

Special Invited Addresses of the Sections:

Raymond Chambers (Southampton)

Informative sampling and sampling information

Daryl Pregibon (Google, Inc.)

Graph Mining

Richard Simon (US National Cancer Institute)

Key features in the design and analysis of DNA microarray studies

Pierre Robillard Award Address (Best Thesis):

Rachel MacKay Altman (Washington)

Hidden Markov Models: Multiple Processes and Model Selection

Canadian Journal of Statistics Award Address:

Belkacem Abdous (Laval), Kilani Ghoudi (United Arab Emirates),

Bruno Rémillard (HEC Montréal)

Nonparametric Weighted Symmetry Tests

24th Annual Meeting of CAIMS

July 16-20, 2003

Organizing Committee: Jacques Bélair (Montréal), (Président, Canada); Ilse Ipsen (North Carolina State), (Président, E.-U.).

The Annual meeting of the Society was held in Montréal, June 16-20. For the first time, the meeting was formally joint with the Society for Industrial and Applied Mathematics (SIAM). There was close collaboration between the two Societies to jointly hold all activities (the scientific ones, foremost), in accord with the identity of each.

The number of participants, close to 550, was sizable for a CAIMS/SCMAI Annual meeting. (Of course, the geographi-

cal origin of the majority of registrants (USA) suggests that the SIAM portion did attract a fraction of these). Two factors apparently negatively influenced this number: 1. a SARS effect, as participants from abroad cancelled in unusual numbers (SIAM had to postpone a meeting scheduled for Toronto the week of June 23 for this reason), and 2. the International Congress, ICIAM, in Sydney (Australia) in early July forced some people to make a geographical choice of destination.

The Organizing committee, in setting the scientific program, tried the usual balancing act of addressing the traditional areas of interest and strength of the Society members, and opening to areas less developed inside the Society, where major developments are taking place, and in which mathematics is playing an increasing role. Anecdotal reports confirm that the overall flavour of the meeting was perceived as somewhat unusual. There were 10 plenary talks (including prize lectures), and 9 topical talks, which are semi-plenary lectures, i.e. only two talks in parallel. These were initiated at SIAM Annual meeting in 2002, and provide an interesting avenue between plenary and sessional talks. Also, there were ample parallel sessions, up to 8 simultaneous ones at one point: this is a consequence of the combined size of the meeting and desire of most attendees to present (an issue which is not significant at "traditional" CAIMS/SCMAI Annual meetings). Overall, the meeting was successful, and of high quality.

AARMS

The Atlantic Association for Research in the Mathematical Sciences (AARMS) was founded in 1995. AARMS exists to encourage and advance research in all mathematical sciences, including statistics and computer science, in the Atlantic region of Canada. In addition, AARMS acts as a regional voice in discussions of the mathematical sciences on a national level. Since its inception, AARMS has played an important role in the research activities in the Atlantic region, sponsoring or co-sponsoring numerous meetings and workshops. In the summer of 2002, AARMS initiated an annual Summer School for graduate students and promising undergraduates.

Since June 2002, AARMS can count on stable long-term funding thanks to co-sponsorship by the three mathematical institutes (CRM, Fields Institute, and PIMS) and the universities of New Brunswick, Memorial, and Dalhousie. Each of the six partners invests 30K\$ per year into the Atlantic mathematical community. MITACS has also contributed important financial resources for industrial mathematical research in the Atlantic provinces. A Scientific Review Panel, including participation from the three institutes and the Atlantic mathematical community, helps the AARMS Director, Dr. Hermann Brunner, in the planning of scientific activities.

As part of the 2003-2004 thematic year on Geometric and Spectral Analysis, we are particularly proud to organize a joint workshop with AARMS. The workshop is on singular integrals and analysis on CR manifolds. It was held in Halifax, Nova Scotia.

Here the list of the joint activities corresponding to the year 2003-2004 of the CRM:

Workshop on Combinatorial Designs and Related Topics

July 14 - 18, 2003

Memorial University

Org.: Rolf Rees & Nabil Shalaby (Memorial)

15th Canadian Conference on Computational Geometry

August 11 - 13, 2003

Dalhousie University

Org.: Michael McAllister (Dalhousie)

Second Annual AARMS Summer School

July 21 - August 15, 2003

Memorial University

Org.: Edgar Goodair (Memorial)

Courses were offered in:

- Cryptography, by Hugh Williams (Calgary)
- Financial Matters, by John van der Hoek (Adelaide)
- Mathematical Biology, by Jianhong Wu (York)
- Partial Differential Equations, by James Robinson (Warwick)

Workshop on Financial Mathematics

August 17 - 20, 2003

Memorial University

Org.: Robert Elliott (Calgary), Edgar Goodaire (Memorial), John van der Hoek (Adelaide)

APICS 2003 / AARMS Research Session in Linear Algebra

October 18 - 19, 2003

University of Prince Edward Island (UPEI)

Org.: Gordon MacDonald (UPEI), Heydar Radjavi (Dalhousie)

International Workshop on Wavelets – Theory and Applications

April 26 - May 7, 2004

University of Prince Edward Island (UPEI)

Org.: Nasser Saad (UPEI)

AARMS-CRM Workshop on Singular Integrals and Analysis on CR Manifolds

May 3 - 8, 2004

Dalhousie University

Org.: Galia Dafni (Concordia), Andrea Fraser (Dalhousie)

CRM Prizes

CRM-Fields Institute Prize was awarded to Donald Dawson

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 Advisory Committee 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), Israel Michael Sigal (2000), William T. Tutte (2001), John B. Friedlander (2002), John McKay and Edwin Perkins (2003).



Professor Donald Dawson during his presentation to the CRM, Friday November 12, 2004.

January 2004: The director by interim of the Centre de recherches mathématiques (CRM) of l'Université de Montréal, Christian Léger, and the Director of the Fields Institute for Research in Mathematical Sciences, Kenneth R. Davidson, are pleased to announce that the CRM-Fields Prize for 2004 is awarded to Professor Donald Dawson in recognition of his exceptional achievement and work in probability.

Donald Dawson, this year's recipient, is one of the world's leading probabilists, having made seminal contributions to the study of spatially distributed stochastic processes and infinite-dimensional branching systems, among those being the Dawson-Watanabe superprocess. He received his B.Sc. from McGill in 1958 and his doctorate from MIT in 1963.

Professor Dawson taught at both McGill University and Carleton University, where he is now Professor Emeritus. His leadership within the Canadian mathematical community includes a term as Director of the Fields Institute from 1996 to 2000. He is a Fellow of the Royal Society of Canada, as well as of the International Statistical Institute and the Institute of Mathematical Statistics.

Other honours include 1991 Gold Medal Lecture of the Statistical Society of Canada, the 1994 Jeffery-Williams lecture of the CMS, an invited lecture at the 1994 ICM, as well as the Fields Institute's Distinguished Lecture Series in the Statistical Sciences. His numerous editorial contributions include serving as co-editor-in-chief of the Canadian Journal of Mathematics. He has served his profession through numerous NSERC and CMS committees, and is currently President-Elect of the Bernoulli Society for Mathematical Statistics and Probability.



Professor Donald Dawson receives the CRM-Fields Prize from CRM director, Professor François Lalonde

André-Aisenstadt Prize 2003-2004 was awarded to Vinayak Vatsal

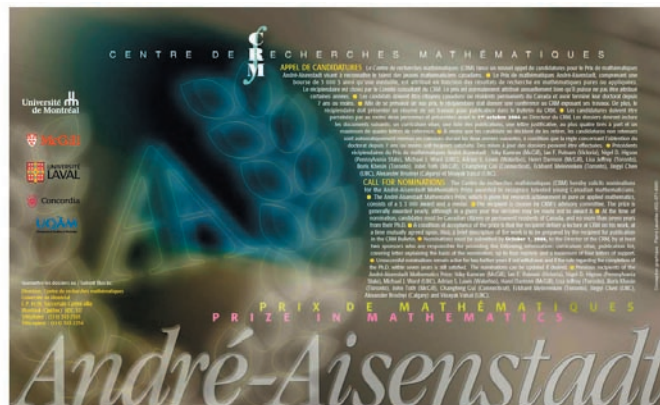
Created in 1991, the André-Aisenstadt Mathematics Prize is intended to recognize and reward talented young Canadian mathematicians. The Prize, which is given for research achievement in pure and applied mathematics, consists of a \$3000 award. The recipient is chosen by the CRM Advisory Committee. At 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), Changgeng Gui (1999), Eckhard Meinrenken (2000), Jingyi Chen (2001) and Alexander Brudnyi (2002).

Vinayak Vatsal

The André-Aisenstadt Prize was awarded to Vinayak Vatsal of the University of British Columbia. Dr. Vatsal obtained his Ph. D. from Princeton University in 1997 under the supervision of A. Wiles. After spending two years as a post-doctoral fellow at the University of Toronto, he joined the staff at the University of British Columbia in 1999. He works in Arithmetic Algebraic Geometry, more precisely in the study of L-functions of elliptic curves. His most spectacular work to date was on the uniform distribution of Heegner points, in which he introduced in a novel and unexpected fashion ideas from ergodic theory. He was thus able to prove a fundamental conjecture of Mazur concerning the L-functions of elliptic curves over anticyclotomic towers (now the Vatsal-Cornut theorem). The Prize was awarded to Dr. Vatsal at a ceremony to held April 2, 2004 at CRM.



Courtesy UBC Science, ©2002 Hot Digital Studios.



CAP-CRM Prize 2004 was awarded to Jiri Patera

Awarded for the first time in 1995, the CAP-CRM Prize is given for outstanding contributions to theoretical and mathematical physics by the Canadian Association of Physicists and CRM. It consists in 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), Gordon W. Semenoff (2000), André-Marie Tremblay (2001), Pavel Winternitz (2002), and Matt Choptuik (2003).

Coming from elementary particle physics, Jiri Patera was attracted very early to the underlying mathematics, and in 1965, while a postdoctoral fellow at the Université de Montréal, he focused his attention on the theory of Lie groups and Lie algebras. The numerous contributions he made with various collaborators (amongst others, P. Winternitz, H Zassenhaus, R. Sharp and R. Moody) have left an indelible mark on this discipline, in which he is now considered to be one of the best specialists in the world. The areas where his contributions were crucial include the representation theory of compact and non-compact Lie groups, generating functions in group representation theory, discrete Fourier analysis on simple and semi-simple Lie groups, and Lie algebra gradings. In 1992, in collaboration with R. Moody, he undertook a remarkable series of investigations on the mathematical properties of quasi-crystals.

Combining a deep physical intuition with an exceptional knowledge of mathematics, Jiri Patera has displayed much inventiveness in proposing new approaches to old problems. He has always managed to choose research topics likely to have practical applications, as testified by the six books he co-authored, which give tables on weight multiplicities and branching rules. His work has had an impact on nuclear and elementary particle physics, quantum chemistry and solid state physics. His research on quasi-crystals even had implications in cryptography.

After staying in Soviet Union for many years, mainly in Moscow and Dubna, Jiri Patera obtained his Ph.D. in 1964 from the Charles University in Prague. He joined the CRM in 1969, and has been a member of the Department of mathematics and statistics of the Université de Montréal since 1983.



CAP-CRM Prize 2004 was awarded to Jiri Patera of Université de Montréal.

CRM-SSC Prize was awarded to Randy Sitter

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), Robert Tibshirani (2000), Colleen Cutler (2001), Larry A. Wasserman (2002) and Charmaine B. Dean (2003).

The CRM-SSC Prize in Statistics was awarded to Dr. Randy R. Sitter, Professor, Department of Statistics and Actuarial Science, Simon Fraser University (SFU), for his outstanding contributions to the statistical sciences, particularly in survey sampling and industrial statistics. The announcement was made at the 32nd Annual Meeting of the Statistical Society of Canada (SSC), held in Montréal, Québec, May 30 to June 2, 2004. This prestigious award, jointly sponsored by the SSC and the Centre de recherches mathématiques de Montréal (CRM), is given each year to a Canadian statistician in recognition of outstanding contributions to the discipline during the recipient's first 15 years after earning a doctorate.



Randy Sitter was born in 1961 in New Westminster, British Columbia. When he was 9, his family moved to Prince George where he attended high school with Deanna, now his wife. He completed a Bachelor's degree in Mathematics in 1984 and a Master's degree in Statistics in 1986 at the University of British Columbia (UBC). He switched to Statistics after a Mathematics Professor once told him "You're good.... but you're not that good. Perhaps you should go into statistics." To finance his studies at UBC, Randy Sitter supported himself doing carpentry and tree planting. Based on data records he kept of his career as a reforester (as might be expected of a future statistician), he estimates that he planted over 300,000 seedlings, which amounts to some 300 hectares of forest regenerated for the benefit of the province.

To pursue doctoral studies, Randy Sitter went to the University of Wisconsin in Madison and worked under the supervision of Professor C.F. Jeff Wu. When the latter accepted a position at the University of Waterloo, Randy Sitter followed him. In 1990, he defended there his Ph.D. thesis entitled "Resampling procedures for complex survey data." As early as January 1990, he became Assistant Professor in the Department of Mathematics and Statistics at Carleton University. While there, he played a major role in the

development of the department's computing resources. He moved to the Department of Mathematics and Statistics at SFU in January 1995 and then became a charter member of the new Department of Statistics and Actuarial Science in May 2001.

Randy Sitter's thesis concerned bootstrap methods which are applicable to complex survey designs of the sort actually in use at statistical agencies. Over the years, he has worked in a variety of areas, making major contributions in survey sampling and in experimental design and industrial statistics. Within these areas, he has worked on variance estimation in complex surveys, imputation, empirical likelihood methods in surveys, optimal design for bioassays, the use of orthogonal multi-arrays for balanced repeated sampling, minimum aberration designs, and more. He published extensively in the most influential journals such as *Technometrics*, *Biometrika*, the *Journal of the American Statistical Association* and *The Canadian Journal of Statistics*, among many others.

Since he earned his doctorate, Randy Sitter has also made outstanding contributions to the profession, notably through graduate supervision, editorial service, involvement in professional statistical societies, the organization of meetings and active participation in the growth of his department at SFU. He has been an Associate Editor of *Survey Methodology*, *Biometrics*, *Technometrics*, and *The Canadian Journal of Statistics*. Since January 2004 he is Editor-Elect of *Technometrics*. He is currently supervising four doctoral students; two more have already graduated: Changbao Wu, now at the University of Waterloo, and Derek Bingham, now holding a Tier II Canada Research Chair at SFU. At the Master's level, Randy has had nine students graduate and is currently supervising two more. A former member of the Executive Committee of the Statistical Society of Ottawa and of the Board of Directors of the SSC, he has also been President of the Survey Methods section of the SSC.

CRM-SSC Prize - continued

In addition to having contributed in a major way to the development of the Department of Statistics and Actuarial Science at SFU, Randy Sitter is a crucial component in its basketball program. He began playing ball at Kelly Road Secondary School. After his first year at UBC, he returned to Prince George to play for the College of New Caledonia basketball team. They were provincial champions in the season 1980-81 and third at the Canadian championships that year. Because "he is tall, but not that tall," Randy Sitter eventually returned to UBC to complete his degree, a choice for which his colleagues at SFU are thankful.



CRM-ISM Colloquium Series

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

CRM-ISM Mathematics Colloquium

Responsibles: Iosif Polterovich (Université de Montréal)

2004

April 30, 2004

Jill Pipher (Brown)

Multiparameter Fourier Analysis

April 23, 2004

Terry Lyons (Oxford)

Rough Paths

April 16, 2004

Gordan Savin (Utah)

Exceptional groups and the arithmetic of cubic fields

March 26, 2004

Alina Stancu (Montréal)

Curvature flows from the viewpoint of convex geometry

March 19, 2004

Charles Newman (Courant Institute of Mathematical Sciences)

Continuum Nonsimple Loops and 2D Critical Percolation

March 12, 2004

Yakov Sinai (Princeton)

Mathematical Hydrodynamics

March 5, 2004

Rafe Mazzeo (Stanford)

Positive scalar curvature and Poincaré-Einstein fillings

February 27, 2004

Ernst Hairer (Genève)

Are linear multistep methods suitable for long-time integration ?

February 20, 2004

Dorothy Buck (Brown. & IHES)

The Topology of DNA-Protein Interactions

February 13, 2004

François Bergeron (UQAM)

Invariants de groupes finis et leurs applications à la combinatoire

January 30, 2004

Ravi Vakil (Stanford)

A geometric Littlewood-Richardson rule

January 23, 2004

Eckhard Meinrenken (Toronto)

Chern-Weil theory and Lie algebras

January 16, 2004

Victor Ivrii (Toronto)

Sharp Spectral Asymptotics for Operators with Irregular Coefficients

2003

December 5, 2003

Victor Havin (St. Petersburg & McGill)

On the separation of singularities of analytic functions

November 28, 2003

Octav Cornea (Montréal)

The Morse complex

November 21, 2003

Stephane Fischler (École Normale Supérieure & Ottawa)

Irrationality of zeta values (after Apéry, Rivoal, ...)

October 24, 2003

Mikhail Sodin (Tel-Aviv)

Growth, zeroes, and area estimates. Variations on the theme

October 17, 2003

Jonathan Pila (McGill)

Integer and rational points on curves and surfaces

October 10, 2003

Robert Russell (Simon Fraser & McGill)

Numerical solution of PDEs using moving grids -- an overview

September 26, 2003

Igor Pak (MIT)

The nature of partition bijections

September 19, 2003

Felix Finster (Regensburg)

The Dirac Sea and the Principle of the Fermionic Projector

September 12, 2003

Gianni Cassinelli (Genoa)

Group Theoretical Quantum Tomography

CRM-ISM-GERAD Statistics Colloquium

Responsibles: Pierre Duchesne (Montréal), Brenda MacGibbon (UQAM), Aruch Sen (Concordia), & George Ph. Styan (McGill).

2004

- April 23, 2004
Christian Genest (Laval)
Tests d'indépendance fondés sur le processus de copule empirique
- April 16, 2004
David Dickson (Melbourne)
The distribution of the time to ruin
- April 2, 2004
Winfried Stute (Giessen, Germany)
Nonparametric Model Checks in Statistics
- March 26, 2004
Jean-Pierre Dion (UQAM)
Quasilielihood Methods in Size-Dependent Branching Processes with Application to Polymerase Chain Reactions (PCR)
- March 19, 2004
David Binder & Georgia Roberts (Direction de la méthodologie, Statistique Canada)
Analysis Issues for Data from Complex Survey
- March 12, 2004
Susan A. Murphy (Michigan)
Dynamic Treatment Regimes, Multistage Decisions and Reinforcement Learning
- March 5, 2004
Jonnagaddan N.K. Rao (Toronto)
Practical Issues in Model-Based Small Area Estimation

2003

- November 28, 2003
Gabor J. Székely (Bowling Green State Univ. & Hungarian Academy of Sciences, Budapest)
Absolute Statistics: \mathcal{E} and s
- November 21, 2003
Bimal Sinha (UMBC)
On some aspects of Tukey's test for nonadditivity with one d.f.
- October 31, 2003
A.S. Hedayat (Univ. of Illinois, at Chicago)
Optimal and efficient crossover designs
- October 17, 2003
John Petkau (UBC)
Neutralizing Antibodies and the Efficacy of Interferon Beta-1b in Multiple Sclerosis Clinical Trials
- October 10, 2003
Bruno Remillard (HEC)
Weighted-symmetry and applications
- September 26, 2003
Jim Berger (Duke)
Statistical Validation of Computer Models

CRM Partners

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 of International Stature

The CRM is strongly committed to its national mission and takes measures to ensure that the largest possible number of scientists across Canada benefits from its activities and become involved in their planning. For instance, it appoints to its Advisory Committee eminent Canadian scientists from various parts of the country; it is present at all important forums where the future directions of the Canadian mathematical sciences are discussed; it urges its organizers to make efforts to ensure the participation of the Canadian specialists in their activities; it organizes and supports scientific events across the country; it collaborates with Canadian institutes, societies and associations. A specific budget is set aside each year for the participation of Canadian graduate students in its programs. The CRM is the only national institute that operates in the two official languages of Canada and it is highly visible on the international scene. In keeping with its national role, it coordinates its activities with the Fields Institute, PIMS, the Canadian Mathematical Society (CMS), 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 coordinating their scientific activities, the three institutes have worked closely on a variety of initiatives, the most important of which has been the Mathematics of Information Technology and Complex Systems, (see Industrial Collaborations section).

There are several other initiatives worthy of mention. One of these is the National Program Committee, described in a separate section. We also participate to the development of the mathematical sciences in the Atlantic provinces through AARMS; see the section on AARMS. The National Program on Complex Data Structures, funded through NSERC's last reallocation exercise, is a joint initiative of the three institutes and the Canadian statistical community. The broad goal of the program is to foster nationally coordinated projects with substantial interactions with the large community of scientists involved in analysis of complex data sets, and to establish a framework for national networking of research activities in the statistical community.

Other initiatives involved two institutes, such as the CRM-Fields prize awarded in recognition of outstanding accomplishments in the mathematical sciences in Canada. It was created in 1994. This year's winners are *John McKay* of Concordia University and *Edwin Perkins* of the University of British Columbia. The administra-

tive responsibility in this matter alternates each year between the CRM and the FI. Scientific collaboration continues between FI and CRM, with a close coordination of the activities for the theme years 2003–2004 in analysis and partial differential equations with two series of two workshops that alternated between the two institutes.

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. We also financially support a number of initiatives of the CMS, such as the mathematical camps, the Canadian School Mathematics Forum 2003, as well as the travel grant program for students who will attend the joint Canada-France meeting in Toulouse in 2004. Together with the other institutes, the CRM organizes or sponsors special sessions at the CMS, CAIMS, and SSC meetings. The CRM awards a prize each year jointly with the SSC; similarly, 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. Moreover, the CRM hosted the 2004 Annual Meeting of the SSC.

International Collaboration

In 2003-2004, on the international scene, the CRM collaborated or received financial assistance from the National Science Foundation (NSF), the Banff International Research Station (BIRS), INSERM in Paris, the Institute of Electrical and Electronics Engineers (IEEE), Alcatel, and the Institute for Mathematics and its Application (IMA).

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 series with Springer-Verlag, in statistics and in mathematical physics. This year, CRM has also published a book jointly with the Institute of Mathematical Statistics. The CRM has exchange agreements with Fields Institute, PIMS, MSRI (Mathematical Sciences Research Institute), the Institute for Mathematics and its Applications, École Normale Supérieure (France), the Isaac Newton Institute, the Institut des Hautes Études Scientifiques (IHES, France), and the Banff International Research Station.

Our Academic Partners

All this activity rests on a solid base of cooperation with universities in the region, in particular the Montréal universities, and most particularly the Université de Montréal, whose support for the CRM has been indefatigable. The Université de Montréal releases five of

its faculty members to work at the CRM each year, and the support of these faculty members is an essential asset for the CRM's scientific activities. There is in addition a regular program of teaching release with the other Montréal universities, bringing the equivalent of another two positions to the CRM each year. On an ad-hoc basis linked to the theme program, the CRM has also been arranging release of research personnel from nearby universities such as Laval, Sherbrooke, Queen's and Ottawa. The partnerships of the CRM with the other research institutes in the Montréal area have been very profitable. The collaborations are mentioned in the section on industrial collaborations.

This year, the CRM initiated a new large-scale partnership with Québec universities that has permitted the establishment of eight interuniversity laboratories headed by the CRM. With the financial support of the Université de Montréal, McGill University, Université de Québec à Montréal, Concordia University, and Université Laval as well as grants from Fonds de recherche québécois sur la nature et les technologies (FQRNT) of Québec and of NSERC, CRM finances the activities of the eight laboratories representing the most active branches of the mathematical sciences. These laboratories are the scene of scientific vitality par excellence and serve to feed the national and international scientific programs of the CRM. Please refer to the section on the Research laboratories for reports describing the activities of each laboratory.

CRM is also pleased to announce a new initiative with the University of Ottawa that began in 2003-2004. In partnership with the University of Ottawa, the CRM co-finances postdoctoral fellowships, a series of CRM-University of Ottawa conferences and teaching releases so that University of Ottawa faculty members can undertake research collaborations with colleagues in the CRM's laboratories or to participate in CRM scientific activities.

Neuro-imaging initiative in Québec

In recent years, CRM's PhysNum laboratory has developed a strong collaborative network with various partners in neuro-imaging in the Montréal area. This network was formalized with the constitution of the "Regroupement Neuro-imagerie Québec" (RNQ) under the umbrella of the Institut Universitaire de Gériatrie in Montréal. RNQ, with its 70 researchers, has recently purchased some key equipment in neuro-imaging through a very large grant (\$11M). One of the strongest alliances of CRM within that network is its association with the INSERM laboratory for brain-imaging at Jussieu - La Salpêtrière, France (director: Habib Benali).

Institut des sciences mathématiques

Another important vehicle for collaboration with the Québec universities is the Institut des sciences mathématiques (ISM). This institute, which encompasses most of Québec's universities, is principally concerned with coordinating 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 organizing two series of CRM-ISM colloquium, one in mathematics and one in statistics, and in organizing special courses for the CRM's thematic programs. Since Summer 2003, the CRM participate in the undergraduate summer scholarships program, which allows postdoctoral fellows to supervise undergraduate students

Industrial Collaborations

The main vehicles for the CRM's efforts in this area are the research networks to which it belongs. There are two of these, one the Network for Computing and Mathematical Modelling (ncm_2), involving eight research centres in the Montréal area and MITACS, a national network focussing on the mathematics of information technology and complex systems.

MITACS

This network of centres of excellence on Mathematics of Information Technology And Complex Systems (MITACS) is one of 21 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.

October 30-31, 2003

Workshop on Environment: Risk and Modeling
Organized by GERAD with CRM and CIRANO

May 6-7, 2004

Network for computing and mathematical Modelling (ncm_2)

The CRM serves as the organizational centre for the Network for Computing and Mathematical Modelling, ncm_2 , a collaboration which allows the network to respond to the needs of industry in a large number of fields related to a common area of computing and mathematical modelling, mostly around five major themes: (1) risk management, (2) information processing, imaging and parallel computing, (3) transport and telecommunications, (4) health and (5) electronic commerce.

The five centres that established the network were the CRM, the Centre de recherche en calcul appliqué (CERCA), the Center for Interuniversity Research and Analysis on Organizations (CIRANO), the Center for Research on Transportation (CRT), and the Group for Research in Decision Analysis (GERAD). Since then, three new members joined the network: the Cooperative Centre for Research in Mesometeorology (CCRM), the Centre de Recherche Informatique de Montréal (CRIM) and the Institut National de la Recherche Scientifique – Télécommunications.

The network organized the following activities:

ncm_2 Grande Conférence presents
Douglas N. Arnold, (Director of the Institute for Mathematics and its Applications)

From Exact Sequences to Colliding Black Holes: Differential Complexes in Numerical Analysis

October 16, 2003

Workshop on Cerebral Plasticity: Imaging and Modeling
Organized by CRM

Bell University Laboratories

The CRM is an active participant in the ncm_2 's Bell University Laboratories, part of a joint project between the ncm_2 and Bell. The laboratories aim at creating innovations in the field of multimedia research and applications (mainly interactive applications aimed at the general public, electronic commerce applications and new generations of evolved networks) as well as at promoting the training of a highly qualified, international calibre workforce in these areas.

Research Laboratories

The CRM now encompasses eight research laboratories at the heart of the Québec mathematical community. These research centers act as focal points for local scientific activity and participate actively in the science direction of the CRM.

CICMA

Centre Interuniversitaire en Calcul Mathématique Algébrique

This centre comprises researchers working in number theory, group theory and algebraic geometry. Contemporary number theory follows two major courses. On the one hand, there is the theory of special values of L-functions attached to arithmetic objects, originating in the work of Gauss and Dirichlet and leading to the modern conjectures of Deligne, Beilinson and Bloch-Kato. On the other hand, the Langlands program postulates a close link between arithmetic L-functions and automorphic representations. An area where these two currents intersect is the study of elliptic curves. The center is particularly well represented in this regard with Darmon, Iovita, and Kisilevsky. CICMA also acquired a new expertise in many aspects of analytic number theory with the recent arrival of Andrew Granville, one of the leaders in the field. On the group theory side, Kharlampovich

and Miasnikov are world-renowned specialists on group varieties and McKay is one of the originators of the moonshine program.

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

Members of laboratory CICMA

Directeur

Henri Darmon (McGill)

Algebraic number theory, geometry, arithmetic, L-functions, diophantine equations, elliptic curves.

Chris J. Cummins (Concordia)

Group theory, modular functions, Moonshine.

Chantal David (Concordia)

Analytical number theory, L-functions.

Jean-Marie De Koninck (Laval)

Analytic number theory: distribution of prime numbers, factorisation of numbers, asymptotic behaviour of arithmetic functions, Riemann zeta function.

Dave Dummit (Vermont)

Théorie algébrique des nombres, géométrie algébrique arithmétique, mathématiques computationnelles.

David Ford (Concordia)

Algorithmic number theory.

Eyal Goren (McGill)

Arithmetic geometry, algebraic number theory, moduli spaces of Abelian varieties, Hilbert modular forms, p-adic modular forms.

Andrew Granville (Montréal)

Analytic number theory, arithmetic geometry, combinatorics.

Adrian Iovita (Concordia)

Number theory, p-adic cohomology.

Members of CICMA laboratory - continued

Olga Kharlampovich (McGill)

Combinatorial theory of groups and Lie algebras.

Hershy Kisilevsky (Concordia)

L-functions, Iwasawa theory, elliptic curves, class field theory.

Claude Lévesque (Laval)

Algebraic number theory, units, class number, cyclotomic fields.

Michael Makkai (McGill)

Mathematical logic.

John McKay (Concordia)

Computational group theory, sporadic groups, computation of Galois groups.

Alexei Miasnikov (McGill)

Group theory.

Ram Murty (Queen's)

Number Theory: Artin's conjecture, Elliptic curves, Modular Forms, Automorphic forms, Langlands Program, Selberg's conjectures, Sieve Methods, Cryptography.

Jonathan Pila (McGill)

Number theory, especially algorithmic and diophantine problems.

Damien Roy (Ottawa)

Transcendental Number Theory.

Peter Russell (McGill)

Algebraic geometry.

Francisco Thaine (Concordia)

Cyclotomic fields, cyclotomy, rational points on curves.

Seminars 2003-2004 - Laboratory CICMA

The traditional Québec-Vermont Number Theory Seminar was held every two weeks in 2003-2004, with speakers from everywhere in the world were came to lecture on the latest programs in the fields: More details can be found at <http://cicma.mathstat.concordia.ca/faculty/chantal/QVNTS/schedule0304.html>.

Speakers: Scott Ahlgren (Urbana), Gil Alon (CICMA), Fabrizio Andreatta (Univ. of Padova), Michael Bennett (UBC), Valentin Blomer (Univ. of Toronto & Stuttgart Univ.), Mei-Chu Chang (UC Riverside), Peter Clark (CICMA), Keith Conrad (Connecticut), John Conway (von Neumann Professor, Princeton University), Henri Darmon (McGill), Stéphane Fischler (Ecole Normale Supérieure), Alexandru Ghitza (CICMA), Eyal Goren (McGill), Ben Green (Cambridge), Christopher Hughes (American Institute of Mathematics), Adrian Iovita (Concordia Univ.), Habiba Kadiri (CICMA), Payman Kassaei (CICMA), Kiran Kedlaya (MIT), Chandrashekhhar Khare (Utah), Sandor Kovacs (Washington), Alan Lauder (Oxford), Greg Martin (UBC), Jean-Francois Mestre (Université Paris 7), Elena Montavan (Berkeley), Robert Osburn (Queens), Ambrus Pal (CICMA), Jonathan Pila (McGill Univ.), Carl Pomerance (Dartmouth College), Fernando Rodrigues Villegas (Texas), Jonathan Sands (Univ. of Vermont), Gordan Savin (Utah), David Savitt (CICMA), Norbert Schlomiuck (Univ. de Montréal), Peter Schneider (Muenster Univ. / Univ. of Chicago), Igor Shparlinski (Macquarie Univ.), Jack Sonn (Technion), Kannan Soundararajan (Univ. of Michigan), Harold Stark (UCSD), Cam Stewart (Waterloo), Lucien Szpiro (CUNY), Eric Urban (Columbia), Nike Vatsal (UBC), Gary Walsh (University of Ottawa), June Zhu (McMaster).

A seminar on cohomology was organized by Eyal Goren. Notes from this seminar are currently written by Eyal Goren and several of the CICMA postdoctoral fellows, and the final result will be a book on the subject. More details can be found at <http://www.math.mcgill.ca/goren/SeminarOnCohomology.html>.

Speakers: Gil Alon, Andrew Archibald, Gabriel Chenevert, Pete Clark, Alex Ghitza, Eyal Goren, Matthew Greenberg, Payman Kassaei, Ratnadhya Kolhatkar, Elena Mantovan, Marc-Hubert Nicole, David Savitt, Shahab Shahabi.

A seminar organized by Henri Darmon and Adrian Iovita on automorphic forms, quaternion algebras and the L-invariant of Greenberg and Stevens was held during the winter term. This led to the joint paper "Families of automorphic forms on definite quaternion algebras and the Mazur-Tate-Teitelbaum conjectures in higher weight" by Darmon and Iovita, which is currently in preparation.

An informal workshop, with participants Chantal David, Jack Fearnley, Hershy Kisilevsky, and occasionally Andrew Granville, was formed to discuss questions on analytic rank of twisted L-functions of elliptic curves and random matrix theory. This leads to 2 joint publications of David, Fearnley and Kisilevsky on links between vanishing of L-functions and random matrix theory.



Geometry and topology are fundamental disciplines of mathematics whose richness and vitality have been evident throughout human history and reflect their deep link to our experience of the universe. They are at a crucial crossing point of modern mathematics and in effect several domains of mathematics have recently shown a strong trend towards a geometrization of ideas and methods: two cases in point are mathematical physics and number theory.

During the last twenty-five years, a group of researchers of international calibre in geometry and topology has been hired by Quebec universities. The research centre, based at UQAM, now comprises fifteen professors-researchers together with a large number of postdoctoral fellows and graduate students. The main themes to be pursued in the coming years include Dehn surgery and Thurston geometrization; quantization of Hitchin systems and geometric Langlands program; classification of special Kähler metrics; the study of symplectic invariants, especially in dimension 4; Hamiltonian dynamical systems.

Members of the laboratory CIRGET

Directeur

Steven Boyer (UQAM)

Low-dimensional geometry and topology.

Syed Twareque Ali (Concordia)

Coherent states, wavelets, quantization techniques, harmonic analysis

Vestislav Apostolov (UQAM)

Complex geometry, Kähler geometry, special metrics.

Abraham Broer (Montréal)

Algebraic geometry, Lie theory, representation theory, invariant theory.

Olivier Collin (UQAM)

Low-dimensional topology, differential geometry, gauge theory.

Octavian Cornea (Montréal)

Algebraic topology, dynamical systems.

John Harnad (Concordia)

Geometric methods in mathematical physics, integrable systems.

Jacques Hurtubise (McGill)

Algebraic geometry, integrable systems, gauge theory, moduli spaces.

André Joyal (UQAM)

Algebraic topology, category theory.

Niky Kamran (McGill)

Differential geometry, partial differential equations.

François Lalonde (Montréal)

Symplectic topology and geometry, global analysis, infinite dimensional transformation groups.

Iosif Polterovich (Montréal)

Complex analysis, functional analysis, spectral theory, potential theory.

Peter Russell (McGill)

Algebraic geometry.

John Toth (McGill)

Spectral theory, semi-classical analysis, micro-local analysis, Hamiltonian mechanics.

Daniel Wise (McGill)

Geometric group theory, low-dimensional topology.

Highlights of the activities of the laboratory and of its members 2003-2004

In 2003-04, CIRGET updated and consolidated its infrastructure: the website was redesigned (<http://www.cirget.uqam.ca>), a database was created, and the CIRGET computer lab at UQAM was remodeled and its equipment brought up-to-date with funding, in part, from one of our FQRNT team grants. The goal to make the lab as flexible as possible was achieved: users can now work from a variety of platforms including Macintosh, Windows, Linux, and Unix. We are in the process of installing a wireless network in the lab.

CIRGET's scientific activity continued to flourish. Six of its members obtained a four-year grant from the NSERC Leadership Support Initiative (LSI) programme in September 2003, one of just seven such grants awarded across the country. We intend to use the funding to organize eight thematic semesters.

Two working groups were set up during the year. One, on J-holomorphic curves and their applications, was organized by François Lalonde and met weekly at the Université de Montréal. The other, on geometrization and Ricci flow, was organized by Vestislav Apostolov, and met at UQAM.

Two CIRGET workshops were held. John Harnad and Jacques Hurtubise organized a workshop on tau-functions which took place at the CRM March 19-20. The speakers and their titles were:

- Marco Bertola (Concordia), *Isomonodromy tau functions and matrix models*
- John Harnad (Concordia), *Character expansion of tau functions*
- Dmitri Korotkin (Concordia), *Isomonodromic tau-function and G-function of Hurwitz Frobenius manifolds*
- Vladimir Matveev (Université de Bourgogne et Steklov - St. Petersburg), *Discrete versions of Darboux-Paschl-Teller potentials*
- Alexey Kokotov (Concordia), *Tau-functions on spaces of holomorphic differentials and determinants of Laplace operator with conical singularities on Riemann surfaces*
- Yousuke Ohshima (Osaka), *A new class of Painlevé transcendents; monodromy solvable solutions*
- Andrei Kapaev (Research Center of Innovation and Developments - St. Petersburg), *Large N asymptotics of spectral curves*
- Jacques Hurtubise (McGill), *The geometry of Calogero-Moser systems*

The second workshop, Trends in 3-manifolds, was organized by two CIRGET postdoctoral fellows, Benjamin Klaff and Stephan Tillmann. It took place May 1-2 at UQAM. The speakers and their titles were:

- Ian Agol (University of Illinois at Chicago), *Tameness of hyperbolic 3-manifolds*
- Danny Calegari (California Institute of Technology), *Quasigeodesic flows and universal circles*
- Nathan Dunfield (California Institute of Technology), *Does a random 3-manifolds fiber over the circle?*
- Stavros Garoufalidis (Georgia Institute of Technology), *The geometry of the Jones polynomial*
- Marc Lackenby (Oxford), *A characterization of large, finitely generated groups*
- Saul Schleimer (University of Illinois at Chicago), *Heegaard splittings and Haken's problem*
- Genevieve Walsh (Austin), *Virtually Haken fillings of fibered knot complements*

CIRGET members have also been active in organizing events at the CRM, BIRS, PIMS as well as elsewhere in the world.

Seminars 2003-2004 – Laboratory CIRGET

In 2003-04, the Geometry-Topology Seminar, organized by Olivier Collin, had 32 speakers of whom 26 were from outside Montreal. The Geometric Group Theory Seminar, organized by Dani Wise, met 19 times and the CIRGET Junior Seminar, organized by Baptiste Chantraine, met 26 times.

Geometry-Topology Seminar

Responsible: Olivier Collin

Speakers: Tara Brendle (Cornell), Denis-Charles Cisinski (Paris 7), Olivier Collin (UQAM), Daryl Cooper (Univ. of California at Santa Barbara), Zindine Djadli (Cergy-Pontoise), Tolga Etgu (McMaster), Stefano Francaviglia (di Pisa), David Gay (UQAM), Tony Geramita (Queen's), Mark Haskins (IHES), Rafael Herrera (Princeton), Alexander Ivrii (CRM), Thalia Jeffres (Michoacana), Barry Jessup (Ottawa), Rob Kirby (Berkeley), Benjamin Klaff (UQAM), John Klein (Wayne State), Joachim Kock (UQAM), Margarita Kraus (Regensburg), Steven Lu (Essen), Georges Maltsiniotis (Paris 7), Gideon Maschler (Toronto), Ion Mihai (Bucharest & Michigan State Univ.), Ramin Mohammadalikhani (CRM), Brendan Owens (McMaster), Saul Schleimer (Univ. of Illinois at Chicago), Margaret Symington (Georgia Tech.), Stephan Tillman (UQAM), Bogdan Vajiac (Indiana), S. Vidussi (Kansas State), Shicheng Wang (Beijing), Gregor Weingart (Bonn).

Geometric Group Theory Seminar

Responsible: Dani Wise

Speakers: Inna Bumagin (McGill), Derrick Chung (McGill), Gabriel Indurskis (UQAM), Misha Kapovich (UC Davis), Raza Ali Kazmi (McGill), John Meier (Lafayette & Columbia), Igor Mineyev (IAS & UIUC), Bogdan Nica (McGill), Denis Serbin (McGill), Ralph Stohr (UMIST), Ted Turner (SUNY Albany), Dani Wise (McGill).

Séminaire CIRGET Junior

Responsible: Baptiste Chantraine

Speakers: Baptiste Chantraine (UQAM), Gabriel Chênevert (McGill), Alexandre Girouard (Montréal), Clément Hyvrier (Montréal), Gabriel Indurskis (UQAM), Benjamin Klaff (UQAM), Joachim Kock (UQAM), Remi Leclercq (Montréal), Olivier Rousseau (Montréal), Stephan Tillman (UQAM).

Mathematical Analysis laboratory

At the same time classical and central to modern mathematics, analysis involves studying continuous systems from dynamical systems to solutions of partial differential equations and spectra of operators. The analysis laboratory was formed just one year ago. Currently the laboratory has 35 members working at ten different universities in Quebec, Ontario, France and the USA, with a particular concentration at Université de Montréal, Laval and McGill. Many of the main currents of modern analysis are studied by the group. Among the research subjects of the group, one finds conjectures on random waves and quantum chaos, Hamiltonian formalism in statistical mechanics far from equi-

librium, asymptotic properties of wave functions, Hilbert 16th problem and Hardy conjecture.

Besides four active seminars (McGill, Laval, Seminar in Non-linear Analysis and Dynamical Systems (Montréal), Analysis and Related Topics (joint colloquium series, University of Sherbrooke and Bishop's University), members of the lab are currently organizing a Year in Geometric and Spectral Analysis at CRM in 2003-2004 which will include twelve conferences and workshops.

Members of the Mathematical Analysis laboratory

Directeur

Dmitry Jakobson (McGill)

Pure mathematics, global analysis, spectral geometry, quantum chaos, harmonic analysis, eigenvalues and eigenfunctions.

Line Baribeau (Laval)

Complex and functional analysis, Banach algebras, holomorphic iterations, discrete groups.

Abraham Boyarsky (Concordia)

Dynamical systems

Francis Clarke (Claude Bernard, Lyon I)

Nonlinear and dynamic analysis, control theory, calculus of variations.

Galia Dafni (Concordia)

Harmonic analysis, partial derivative equations, complex variables.

Donald Dawson (Carleton)

Probability, stochastic process.

Stephen Drury (McGill)

Harmonic analysis, matrix theory.

Richard Duncan (Montréal)

Ergodic theory, probability.

Richard Fournier (Dawson College)

Probability, stochastic processes.

Marlène Frigon (Montréal)

Nonlinear analysis, differential equations, fixed point theory, critical point theory, multivalent analysis.

Martin Gander (McGill)

Domain decomposition, preconditioning.

Paul Gauthier (Montréal)

Complex analysis, holomorphy, harmonicity, analytic approximation.

Pawel Gora (Concordia)

Ergodic theory, dynamic systems, fractal geometry.

Frédéric Gourdeau (Laval)

Banach algebras, cohomology, amenability, functional analysis.

Kohur GowriSankaran (McGill)

Potential theory.

John Harnad (Concordia)

Mathematical physics, classical and quantum physics, geometrical methods, integrable systems, group theoretical methods, random matrices, isomonodromic deformations, isospectral flows.

Antony R. (Tony) Humphries (McGill)

Numerical analysis, differential equations.

Vojkan Jaksic (McGill)

Quantum mechanics, statistics, random Schrödinger operators.

Tomasz Kaczynski (Sherbrooke)

Topological methods, Conley index, applications to dynamical systems.

Niky Kamran (McGill)

Differential geometry, partial differential equations, mathematical physics.

Ivo Klemes (McGill)

Harmonic analysis, trigonometric series.

Paul Koosis (McGill)

Harmonic analysis.

Dmitry Korotkin (Concordia)

Integrable systems, isomonodromic deformations, classical and quantum gravity, Frobenius varieties.

Javad Mashreghi (Laval)

Complex analysis, harmonic analysis, Hardy spaces.

Nilima Nigam (McGill)

Applied analysis, numerical methods in electromagnetism.

Yiannis Petridis (CUNY, Lehman College)

Automorphic Forms and Spectral Theory. L-Functions, Quantum chaos.

Members of the Mathematical Analysis laboratory - continued

Iosif Polterovich (Montréal)

Complex analysis, functional analysis, spectral theory, potential theory, Jensen measures.

Thomas Ransford (Laval)

Complex and harmonic analysis, functional analysis and theory of operators, spectral analysis, potential theory.

Dominic Rochon (UQTR)

Numbers, analysis, dynamic complexes.

Jérémie Rostand (Laval)

Complex analysis, experimental mathematics.

Christiane Rousseau (Montréal)

Dynamical systems, bifurcations, qualitative theory, polynomial systems, analytic invariants, integrable systems.

Dana Schlomiuk (Montréal)

Global analysis, dynamical systems, singularities, bifurcations, algebraic curves, primary integral.

Georg Schmidt (McGill)

Control of partial differential equations.

Ron Stern (Concordia)

Functional analysis and theory of operators, linear and non-linear systems, non-smooth analysis, stability, optimal order.

John Toth (McGill)

Spectral theory, semi-classical analysis, micro-local analysis, Hamiltonian mechanics.

Samuel Zaidman (Montréal)

Highlights of the activities of the laboratory and of its members 2003-2004

- J. Rostand (Laval) have recently become members of the lab.
- A member of our lab, Line Baribeau (Laval), has been promoted to full professor with effect from June 1, 2004. Many congratulations!
- Some of the activities of the lab are described on the "Analysis in Quebec" web page, <http://www.math.mcgill.ca/jakobson/analysis/analysis.html>
- Conference in Classical Analysis in Honor of Paul Koosis (October 23-26, 2003). This conference was organized by G. Dafni (Concordia), D. Jakobson (McGill), J. Mashreghi (Laval).

Conference in Classical Analysis in Honor of Paul Koosis

Invited Speakers:

David Drasin (NSF), *Positive harmonic functions in T -automorphic domains*

John Garnett (UCLA), *Analytic Capacity, Cauchy Integrals, Bilipschitz Maps and Cantor Sets*

Victor Havin (St. Petersburg & McGill), *Variations on a theme by Beurling and Malliavin*

Walter Hayman (Imperial College), *ABC, Waring and Fermat for functions*

Peter Jones (Yale), *Brownian Motion and Bounded Square Functions: Joint Work with Paul Muller*

Jean-Pierre Kahane (Orsay), *Old and new results on partial sums of Fourier series*

Ivo Klemes (McGill), *Extension of a lemma of Gohberg and Krein*

Paul Koosis (McGill) *A lemma about being analytic. Applications of the same (if time permits)*

Javad Mashreghi (Laval), *Entire function of exponential type, binomial sums and Banach algebras*

Robert Milson (Dalhousie), *On the abstract definition of a differential operator*

Fedya Nazarov (Michigan State), *Sharp bound for the area of the set of positivity of a harmonic function with prescribed number of sign changes on the boundary*

Louis Nirenberg (Courant), *Distance function to the boundary and Hamilton-Jacobi equations*

Henrik L. Pedersen (Royal Veterinary and Agricultural University), *Entire functions and logarithmic sums*

Tom Ransford (Laval), *Cyclic vectors in the Dirichlet space*

Misha Sodin (Tel Aviv), *Growth, zeroes, and area estimates. Variations on the theme*

Sergey Treil (Brown), *The Operator Corona Problem and geometry of holomorphic vector bundles*

Sasha Volberg (Michigan State), *Applications of nonhomogeneous Harmonic Analysis: capacities, perturbations of unitary operators, dynamics*

Michael Wilson (Vermont), *Some Littlewood-Paley results*

Reem Yassawi (Trent), *Asymptotic randomisation of measures by Cellular Automata on Sofic Shifts*

Analysis - Université de Montréal

Responsible: Paul Gauthier (Montréal).

Speakers: Richard Fournier, (CRM, Montréal, & Collège Dawson).

Analysis - Université Laval

Responsible: Javad Mashreghi (Laval).

Speakers: Ariel Blanco (Laval), Frédéric Gourdeau (Laval), Abdessamad Safoui (Marrackech).

Analysis and Related Topics

Responsibles: Tomasz Kaczynski (Sherbrooke), Tilak Bhattacharya (Bishop's), François Dubeau (Sherbrooke), Madjid Allili (Bishop's).

Speakers: André Bandrauk (Sherbrooke), Tilak Bhattacharya (Bishop's), Michel Delfour (Montréal), Marlène Frigon (Montréal), Wieslaw Krawcewicz (Alberta), Konstantin Mischaikow (CDSNS, Georgia Institute of Technology), Christiane Rousseau (Montréal), Alina Stancu (Montréal), Michel Virgilio (Sherbrooke), Lourdes Zubieta (Bishop's).

Seminar in Nonlinear Analysis and Dynamical Systems

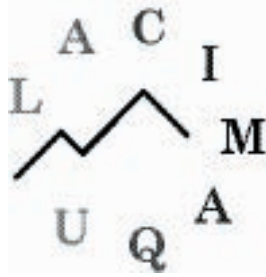
Responsibles: Pietro-Luciano Buono (CRM), Alina Stancu (Montréal).

Speakers: Joan Carles Artés (Autonoma de Barcelona (Spain)), Pietro-Luciano Buono (Montréal), Michael Gage (Rochester), Alexandre Girouard (Montréal), A. El Khalil (Montréal), François Lalonde, (Montréal), Konstantin Mischaikow (Georgia Tech), Alexei Penskoi (Montréal), Christiane Rousseau (Montréal), Dimiter Vassilev (UQAM), Elisabeth Werner (Case Western Reserve).

McGill Analysis

Responsible: Dmitry Jakobson (McGill).

Speakers: Emily Dryden (Dartmouth), Pengfei Guan (McMaster), Daniel Grieser (Bonn), Victor Ivrii (Toronto), Michael Levitin (Heriot-Watt), Stanislav Molchanov (North Carolina), Fedya Nazarov, Alexander Pushnitski (Loughborough), Philong Thanh (McGill), Ignacio Uriarte-Tuero (Yale).



LaCIM

(Laboratoire de combinatoire et d'informatique mathématique)

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

Research areas

Discrete mathematics has lately become an important field of practical research, witness the new heading in *Mathematical Reviews* 05E of algebraic combinatorics with subheadings indicating interactions with the newest areas of mathematics, such as group representations, quantum groups, discrete algebraic geometry, special functions. Combinatorics benefits from the revival of the concrete computational aspect in mathematics after decades of abstract structuralism. Algebra is enriched in a fundamental manner by combinatorics, as the commutative algebra book by Eisenbud demonstrates, highlighting constructive geometric methods. Moreover, combinatorics applies to computer sciences (theory of automata, analysis of algorithms), to statistical physics (computation of configuration spaces and of critical exponents, discrete models), bio-informatics (combinatorics of words applied to genomic sequences). The youth, dynamism, utility and applicability of this research domain are highlighted in the modern world, where discrete structures (trees, graphs, permutations) are more and more present in communications, networks and research engines, of which the use is growing exponentially in this 21st century.

The researchers

The laboratory is comprised of twelve principal researchers, ten of them professors at UQAM, one at McGill and one at Université de Montréal; of ten associate members and four associated in North America, one in Chile and two in Europe. Notably, Christophe Reutenauer (regular member) and Nantel Bergeron (associate member, York University) hold Canadian research chairs. A team of four LaCIM members is supported by a grant from FCAR. André Joyal, past member of LaCIM and current member of CIRGET, is involved in several activities at LaCIM, both formal and informal. LaCIM is the largest research group in combinatorics in Canada and is known worldwide in its field. The UQAM team has contributed to the emergence and establishment of combinatorics as a mathematical discipline. For example, several LaCIM members have played and continue to play an important role in the organization of the international colloquium *Séries formelles et combinatoire algébrique*, which is bilingual and is held yearly, alternately in Europe and North America. Its success is without question.

Research activities at LaCIM

A. Joyal enriched the counting theory of Polya by including the theories of group representations and symmetric functions. Under the name of theory of species, this theory marked the emergence of the UQAM combinatorics group about twenty years ago. From that time research has diversified greatly at LaCIM: a) classical enumerative combinatorics and its applications (counting of discrete configurations and planar maps); b) algebraic combinatorics; c) theoretical computer science; d) bio-informatics.

Members of the LaCIM

Directeur

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

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

Luc Bélair (UQAM)
Mathematical logic, model theory.

Anne Bergeron (UQAM)
Bio-informatics.

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

Nantel Bergeron (York Univ.)
Applied algebra

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

Srecko Brlek (UQAM)
Combinatorics of words, algorithmics.

Cedric Chauve (UQAM)
Enumerative combinatorics, trees, bio-informatics.

Sylvie Hamel (Montréal)
Bio-informatics and algorithms, language and automaton theory, algebraic combinatorics.

André Joyal (UQAM)
Algebraic topology, theory of categories.

Gilbert Labelle (UQAM)
Enumerative combinatorics, analysis.

Jacques Labelle (UQAM)
Combinatorics, topology.

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

Pierre Leroux (UQAM)
Enumerative and algebraic combinatorics.

Vladimir Makarenkov (UQAM)
Computational biology, mathematical classification.

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

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

Highlights of the activities of the laboratory and of its members 2003-2004

Collaborations between members

As mentioned last year, the number of collaborations between LaCIM members, which demonstrates the dynamism and cohesion of the group, were numerous: Bergeron-Chauve in bio-informatics (with a new postdoctoral collaborator, Annie Château); Brlek-Hamel-Reutenauer in combinatorics of words; Leroux-Labelle in theory of categories; Brlek-Labelle in pattern recognition; Laforest-Labelle in data structures; Bergeron-Reutenauer in algebraic combinatorics.

Visitors

LaCIM hosted several visitors: Juhani Karhumäki (Turku), invited by Srecko Brlek. David Liben-Nowell (MIT) in bio-informatics, collaborators of Cédric Chauve and Anne Bergeron; Guillaume Fertin and Guillaume Blin (Nantes), collaborators of Cédric Chauve in bio-informatics; Philippe Caldero (Lyon) and Volker Heiermann (Berlin), collaborators of Robert Bédard; Valérie Berthé (Montpellier), Jean-Pierre Borel (Amiens), Michel Koskas (Amiens), Michel Mendès France (Bordeaux), and Jean Berstel, invited by Srecko Brlek and Christophe Reutenauer, for collaborative work in the combinatorics of words; Florent Hivert (Marne la Vallée and Moscow), who collaborates with François Bergeron and Nantel Bergeron; in May 2004, a working group in combinatorics of words, led by Srecko Brlek, will bring together Sébastien Ferenczi and Julien Cassaigne (Marseille), during ten days on the Montréal-Vancouver train; Mark Haiman (Berkeley) and Adriano Garsia (San Diego), invited by François Bergeron; Sergey Fomin, invited by François Bergeron and Robert Bédard for the ACFAS Congress in May 2004.

- Gilbert Labelle was a member of the scientific committee of scientific of the FPSAC conference held in Vancouver in June 2004.
- Denis Thérien holds a James McGill Chair at McGill University (2002-2009).
- Christophe Reutenauer holds a Canada Research Chair in Combinatorial Algebra and Mathematical Computing (2001-2008).

Séminaire de combinatoire et informatique mathématique

Responsibles: Cedric Chauve & Pierre Leroux (UQAM).

Speakers: Robert Bédard (UQAM), François Bergeron (LaCIM-UQAM), Nantel Bergeron (York), Jean Berstel (Marne-la-Vallée), Valérie Berthé (LIRMM), Riccardo Biagioli (LaCIM-UQAM), Jean-Pierre Borel (Limoges), Annie Château (LaCIM-UQAM), Sara Faridi (UQAM), Guillaume Fertin (IRIN, Nantes), Samuel Fiorini (Univ. libre de Belgique & GERAD-HEC), Adriano Garsia (Univ. de la Californie à San Diego), Tony Geramita (Queen's & Genova), Mark Haiman (Univ. de la Californie à Berkeley), Sylvie Hamel (Montréal), Michel Koskas (LARIA (Amiens)), Jacques Labelle (UQAM), Pierre Leroux (UQAM), Vadim Lioubimov, Pierre Mathieu (Laval), Peter McNamara (UQAM) Karen Meagher (Ottawa), Michel Mendès-France (Bordeaux), Igor Pak (MIT), Simon Plouffe, Étienne Rassard (MIT), Mercedes Rosas (LaCIM-UQAM), Bruno Salvy (INRIA), Mark Skandera (Dartmouth College), Benjamin Steinberg (Herzberg Labs, Carleton), Adrian Vetta (McGill), Timothy Walsh (LaCIM-UQAM).

Applied Mathematics Laboratory

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

The laboratory members work in a wide range of applications (fluids, solids, physics, biology etc.) using a wide variety of tools (optimisation, numerical analysis, dynamical systems, etc). The objective of the new applied math laboratory is to further en-

courage scientific exchanges both amongst its members and outside group. It is characterized by the intensity of its multi-disciplinary collaborations, with all its members working on the development of mathematical models and numerical methods for applications to science and engineering. The laboratory has two regular seminars running during the academic year, a weekly applied mathematics seminar and a biweekly computational science and engineering seminar. It also supports postdoctoral fellows and summer students as well as Canadian and international visitors.

Members of the Applied Mathematics Laboratory

Directeurs

Anne Bourlioux (Montréal)

Modeling, numerical simulation in turbulent combustion.

Martin Gander (McGill)

Domain decomposition, preconditioning.

Jacques Bélair (Montréal)

Dynamical Systems in physiology.

Paul Arminjon (Montréal)

Numerical methods in fluid mechanics.

André Bandrauk (Sherbrooke)

Quantum chemistry.

Peter Bartello (McGill)

Turbulence, CFD.

Michel Delfour (Montréal)

Control, optimization, design, shells, calculus, biomechanics.

Tony Humphries (McGill)

Numerical analysis, differential equations.

Sherwin A. Maslowe (McGill)

Asymptotic methods, fluid mechanics.

Nilima Nigam (McGill)

Applied analysis, numerical methods in electromagnetism.

Georg Schmidt (McGill)

Control of partial differential equations.

Jian-Jun Xu (McGill)

Asymptotics and Numerical Analysis, Nonlinear PDEs material science.

Jean-Paul Zolésio (INRIA)

Control, optimization.

Highlights of the activities of the laboratory and of its members 2003-2004

The members of the applied mathematics laboratory are very active in both research and training, supervising a large number of graduate students and post-doctoral fellows. One characteristic of this laboratory is the sustained collaboration of its members with researchers in other fields: for instance, **Nilima Nigam** is a member of RQMP (Regroupement Québécois des matériaux de pointe), **Martin Gander** and **Michel Delfour** are members of GIREF, **Anne Bourlioux** collaborates with computer scientists and mechanical engineers in an industrial project sponsored by Mitacs, while **Peter Bartello**, **André Bandrauk**, and **Sebius Doedel** hold positions completely or partly outside mathematics departments.

The core activity of the laboratory is the weekly applied mathematics seminar that takes place on Mondays at McGill. It was organized this year by **Tony Humphries**, who succeeded at lining up 24 speakers covering a very wide range of interesting topics in applied mathematics. The laboratory was also involved in organizing and sponsoring the bi-weekly Computational Science and Engineering Seminar at McGill, organized this year by **Luca Cortelezzi**, (Mechanical Engineering, McGill). Several of the laboratory visitors, including **A. Fortin** (Laval), **V. Dolean** (Ecole Polytechnique, Paris), **A. St Cyr** (NCAR, Boulder), **A. Spence** (Bath), spoke in the CSE seminar.

Besides those regular activities, the laboratory organized the first edition of what is to become a yearly activity in numerical analysis, aimed at the Quebec and surrounding community - **the Montreal Scientific Computing Days**. This first edition was a great success as it attracted more than 70 registered participants from Quebec and Ontario. It was a 2-day (weekend) activity, with two main speakers lecturing on recent developments in scientific computing at a level accessible to advanced graduate students, along with oral and poster presentations by local, junior researchers. One ingredient of the success was the prestige of the two main speakers, **E. Hairer** (Geneva) and **E. Darve** (Stanford).

The laboratory members were also hosts to a number of scientific visitors. **E. Hairer** is one of them: the Scientific Computing days were organized around his visit, as well as his conference at the CRM-ISM colloquium. Another long term visitor sponsored in part by the laboratory was **Bob Russell** (SFU) who spent the fall at McGill while being on sabbatical leave. He also gave one colloquium, as well as two seminars, and had many interactions with several laboratory members.

The laboratory members are also very visible at the national level in applied and industrial mathematics. **André Bandrauk** was elected a Fellow of the American Association for the Advancement of Science in October 2003 and **Michel Delfour** was a John Simon Guggenheim Memorial fellow for 2003-4. Several members were actively involved in the joint SIAM-CAIMS annual meeting in Montreal, June 2003: **Anne Bourlioux** as a member of the scientific organizing committee, **Michel Delfour** as a plenary lecturer, **André Bandrauk**, **E. Doedel**, **Martin Gander**, **Tony Humphries**, **Nilima Nigam**, and **Paul Tupper** as mini-symposia organizers or speakers. **A. Bandrauk** was on the organizing committees for the First Canadian Workshop on Ultrafast Dynamic Imaging at Orford in October 2003, and the NRC Ottawa workshop on Dynamic Imagery. **Tony Humphries** was a deputy director of the CRM.

For the forthcoming year, **Anne Bourlioux** has just been elected to the board of directors of CAIMS, and several members of the lab are involved in organizing and participating in various symposia during the 2004 CAIMS annual meeting (joint with CMS, to be held in Halifax): J. Belair (who has just joined the lab), T.Humphries, E. Doedel, M.Gander.

Seminars 2003-2004 Applied Mathematics Laboratory

Applied Mathematics

Responsibles: Michel C. Delfour (CRM), Antony R. (Tony) Humphries (McGill), Paul Tupper (McGill), José Manuel Urquiza (CRM).

Speakers: Jean-Pierre Aubin (Paris-Dauphine), Stefanello Boatto (McMaster), Stéphane Dellacherie (CRM), Selim Esedoglu (UCLA), Guido Kanschat (Heidelberg), Olivier Lafitte (Paris 13, CEA - Saclay), M. Laforest (École Polytechnique Montréal), Claude LeBris (CERMICS-ENPC), Tony Lelièvre (CRM), André Longtin (Ottawa), Sherwin Maslowe (McGill), Alexander Melnikof, (Alberta), Peter Monk (Delaware), Arian Novruzzi (Ottawa), Robert Owens (Montréal), Jan Sieber (Bristol), David Straub (AOS - McGill), Andrea Toselli (ETH Zürich), Thomas P. Wihler (Minnesota), Dongbin Xiu (Princeton).

Mathematical Physics Laboratory

The mathematical physics group is one of the oldest and most active within the CRM. It consists of 20 regular members, all full time faculty members attached permanently to five different Quebec Universities. (Eight of these are also associated with the CRM Analysis Laboratory or with CIRGET, and one with CICMA). In addition, the Lab includes two attachés de recherches, numerous postdoctoral fellows (currently 19, of whom 11 are concurrently attached to one of the other laboratories mentioned) and a large number of graduate students (currently over 40, about 1/3 of whom are working with members attached also to the CIRGET or Analysis laboratories).

The group carries out research in several of the most significant areas of current interest in mathematical physics, such as: Coherent nonlinear systems in fluids, optics and plasmas; classical and quantum integrable systems; spectral theory of random matrices; percolation phenomena; conformal field theory; quantum statistical mechanics; spectral and scattering theory of random Schrödinger operators; quasi-crystals; relativity; spectral transform methods; asymptotics of eigenstates; foundational questions in quantization (stochastic and geometric quantization); coherent states; supersymmetry; symmetry analysis of P.D.E.'s; symmetries and integrability of difference equations; representation theory of Lie groups and quantum groups; and the mathematical structure of classical and quantum field theories.

Members of the Mathematical Physics

Directeur

John Harnad (Concordia)

Mathematical physics, classical and quantum physics, geometrical methods, integrable systems, group theoretical methods, random matrices, isomonodromic deformations, isospectral flows.

Syed Twareque Ali (Concordia)

Coherent states, wavelets, quantization techniques, harmonic analysis, Wigner functions.

Marco Bertola (Concordia)

Axiomatic quantum field theory, invariant theory of discrete groups, random matrices, isomonodromic deformations.

Chris Cummins (Concordia)

Group theory applications to mathematical physics, modular functions and their relation to sporadic groups.

Alfred Michel Grundland (UQTR)

Symmetry of differential equations in physics.

Richard L. Hall (Concordia)

Quantum mechanics, geometry, spectral inversion, many-body problem.

Jacques Hurtubise (McGill)

Algebraic geometry, integrable systems, gauge theory, moduli spaces.

Véronique Hussin (Montréal)

Quantum mechanics, differential equations, Lie groups, Lie algebras, group deformations, supersymmetries.

Dimitry Jakobson (McGill)

Quantum Chaos, Spectral Geometry, Harmonic Analysis.

Vojkan Jaksic (McGill)

Mathematical physics, quantum statistical mechanics, random Schrodinger operators.

Niky Kamran (McGill)

Differential Geometry, partial differential equations, mathematical physics.

Dmitry Korotkin (Concordia)

Integrable systems, isomonodromic deformations, classical and quantum gravity, Frobenius varieties.

François Lalonde (Montréal)

Symplectic topology and geometry, global analysis, infinite dimensional transformation groups.

Jean LeTourneux (Montréal)

Symmetry properties of systems, special functions.

Pierre Mathieu (Laval)

Conformal field theory, classical and quantum integrable systems, affine Lie algebras.

Jiri Patera (Montréal)

Applications of group theory, quasi-crystals, Lie algebras.

Yvan Saint-Aubin (Montréal)

Conformal field theory, statistical mechanics, 2-dimensional phase transition model.

John Toth (McGill)

Partial differential equations, mathematical physics and spectral theory.

Luc Vinet (McGill)

Symmetric properties of systems, special functions.

Pavel Winternitz (Montréal)

Methods of group theory in physics, nonlinear phenomena, symmetries of difference equations, superintegrability.

Members of the Mathematical Physics laboratory

Stéphane Durand

(Collège Edouard-Montpetit)

Classical and quantum physics, mathematical physics, symmetries, parasymmetries, fractional supersymmetries, KdV, quantum mechanics, relativity.

Carolyn Van Vliet (Miami)

Non-equilibrium statistical mechanics, fluctuations and stochastic processes, quantum transport in condensed matter, electronic behavior in submicron quantum devices.

Highlights of the activities of the laboratory and of its members 2003-2004

The members of the Laboratory maintain active ties and ongoing collaborations with other researchers from centers in mathematical physics around the world. The list of scientific visitors to the laboratory this academic year included:

Vasile Brinzanescu (Bucharest) (May 10 - 24 2004)

G. Cassinelli (Genova) (Sept. 8 - 20 2003)

S. De Bievre (Lille) (Sept. 5 - 20, 2003)

V. Dorodnitsyn (Moscow) (Jan. 17 - Feb. 8, 2004)

Miroslav Engliš (Sept. 26 - Oct. 14 2003)

Bertrand Eynard (Saclay) (Feb. 2 - 12, April 2004)

V. Enolskii, (Kiev) (May 22-28, 2004)

D. Grieser (Berlin) (Aug. 20 - Sept. 5, 2003, June, 2004)

Andrei Kapaev (St. Petersburg) (Mar. 1 - 31, 2004)

A. Klimyk (Ukrainian Acad. Sciences, Kiev) (18 Nov - 12 Dec. 2003)

A. Kokotov (St. Petersburg) (Jan. 1 - May 31 2004)

Decio Levi (Rome) (Nov. 23 - Dec. 9 2003). Luigi Martina (Lecce) (July, Aug. 2003)

V. Matveev (Dijon) (Feb. 29 - April 10 2004)

Maung Min-Oo (McMaster) (Aug. 2003)

Yousuke Ohyama (Osaka) (Mar. 4 - Apr. 2, 2004)

Shoji Okumura (Osaka) (Feb. 29 - Mar. 19, 2004)

E. Previato (Boston) (Mar. 22-28, 2004)

I. Rivin (Temple) (visiting Jakobson)

Miguel A. Rodriguez (Madrid) (July 2003)

Z. Rudnick (Tel-Aviv) (Apr. 20. - May 10, 2004)

Misha B. Sheftel (Istanbul) (Jan. 2004 - Feb. 2004, Summer 2004)

A. Soshnikov (UC Davis) (Nov. 20 - 24)

Zora Thomova (SUNY) (Oct. 10-14, Nov. 26-30 2004)

Steve Zelditch (Johns Hopkins) (Nov. 2 - 11, 2003, Jan. 5 - 10, 2004). 5 au 10 janvier 2004).

Stéphane Durand, lecturer at the Physics Department of Université de Montréal received the “Petit Nobel de pédagogie” from the Department.

- **Jiri Patera** was awarded the joint CRM-CAP Prize in Mathematical Physics for 2003-2004.
- Several members of the laboratory (**Vojkan Jaksic, Niky Kamran, John Toth**) were organizers for this year's CRM thematic year on Geometry and Spectral Analysis.

Seminars 2003-2004 Mathematical Physics Laboratory

The regular CRM Mathematical Physics seminar series was continued throughout the academic year, with weekly talks given both by invited visitors and local members of the Lab, including postdoctoral fellows and some graduate students near to completion of their doctorates. In addition, a second “working seminar in mathematical physics” was organized by V. Jaksic at McGill, with active participation by members of the Analysis Lab. (A list of the titles for these two series' may be found at the web sites: http://omega.crm.umontreal.ca/~physmath/calendriers/seminaire_fr.html and: <http://www.math.mcgill.ca/jaksic/wsmp.html>)

Statistics Laboratory

Statistics is central to many endeavours in society. Whether it be through surveys from sampling, clinical trials to study various biomedical treatments or experimental designs in agriculture or industry, statistical methodology can be found everywhere in science. Recently, statistics has been undergoing a revolution in its techniques and its approaches. This revolution has been driven by the need to analyze very large data sets, data with more complex structure, and by the advent of powerful computers. For example, statistical methodology is now addressing problems whose structure is more complex, such as brain images or genome data and new methodology is developed for large data sets. Data-

mining is one of the tools used. The laboratory aims at structuring the Québec community to engage with this revolution at a time of an important renewal of academic personnel. This structure allows the Québec community to benefit from a new pan-Canadian program in analysis of complex data organized by the three Canadian mathematics institutes. The laboratory is composed of the leaders of the Québec school of statistics who work on subjects such as statistical learning and neuronal networks, survey sampling, analysis of functional data, statistical analysis of images, dependence structures, Bayesian analysis, analysis of time series and financial data, as well as resampling methods.

Members of the Statistics Laboratory

Directeur

Christian Léger (Montréal)

Resampling methods, adaptive estimation, model selection, robustness, applications in data mining.

Jean-François Angers (Montréal)

Decision theory, Bayesian statistics, robustness with respect to prior information, function estimation.

Yoshua Bengio (Montréal)

Statistical learning algorithms, neural networks, nucleus models, probabilistic models, data mining, applications in finance and statistical language modelling.

Martin Bilodeau (Montréal)

Multivariate analysis, decision theory, asymptotic methods.

Yogendra Chaubey (Concordia)

Sampling, linear models, resampling, survival analysis.

René Ferland (UQAM)

Probability, stochastic processes, applications to mathematical finance.

Christian Genest (Laval)

Multidimensional data analysis, dependence measures, nonparametric statistics, decision theory, applications in actuarial science, finance and psychology.

Nadia Ghazzali (Laval)

Multidimensional data analysis, neural networks and genetic algorithms, applications in astrophysics and biostatistics.

Brenda MacGibbon (UQAM)

Mathematical statistics, decision theory, biostatistics.

François Perron (Montréal)

Decision theory, multidimensional data analysis, Bayesian statistics.

Jim Ramsay (McGill)

Functional data analysis, smoothing and nonparametric regression, curve registration.

Bruno Rémillard (HEC Montréal)

Probability, empirical processes, time series, nonlinear filtering, applications in finance.

Louis-Paul Rivest (Laval)

Linear models, robustness, directional data, sampling, applications in finance.

Roch Roy (Montréal)

Time series analysis, predictive methods, applications in econometrics and epidemiology.

David B. Wolfson (McGill)

Changepoint problems, survival analysis, Bayesian statistics, optimal design, applications in medicine.

Keith J. Worsley (McGill)

Statistics of brain mapping, geometry of random images in medicine and astrophysics.

News and highlights

Many good news originate from this laboratory. The most important one is that **Louis-Paul Rivest** was awarded a senior Canada Research Chair (CRC) in statistical sampling and data analysis. This is one of the first CRC in statistics. As a recognition of excellence throughout his career, **Keith Worsley** has been nominated James McGill Professor. Moreover, he just received the Statistical Society of Canada's (SSC) Gold Medal awarded to a senior statistician for his substantial contributions to statistics. **Bruno Rémillard** is one of the authors of the paper selected as the winner of the Canadian Journal of Statistics award for 2003. **Yoshua Bengio** is a member of the scientific committee of the prestigious conference entitled NIPS 2004. **Christian Léger** is a member of NSERC's grants selection committee in statistics. He is also the Chair of the local organizing committee of the 2004 Annual Meeting of the SSC which took place at CRM while **Christian Genest** chaired the scientific committee. **Jean-François Angers** completed his mandate on the SSC Executive as Public Relations Officer while **Jim Ramsay** ended his mandate as Past President.

Activities

The laboratory continued organizing the CRM-ISM Statistics Colloquium that began Winter 2003. In February, **Jim Ramsay** gave a two-day workshop on functional data analysis. Despite a lack of time for proper advertising, this activity attracted 39 participants, including many students. This workshop covered many topics of functional data analysis, from the basics to some advanced issues. The most important scientific activity of the laboratory this year is, without a doubt, **DeMoSTAFI** (Dependence Modelling: Theory and Applications in Finance and Insurance) which took place at Université Laval in May 2004. This three-day international conference attracted 112 participants from 18 countries. Organized by **Christian Genest**, it brought together the best researchers working on copulas, including nine invited speakers. A special issue of the most important actuarial journal, *Insurance: Mathematics and Economics*, will be devoted to finance and actuarial papers presented at the conference. Moreover, a special issue of the *Canadian Journal of Statistics* will be devoted to papers with a more statistical flavour that were also presented at that conference. This impact of this activity will therefore be felt well beyond the laboratory and will further improve CRM's image with the Canadian statistical community.

Seminars 2003-2004 - Statistics laboratory

Statistics McGill

Responsibles: George P.H. Styan, Keith J. Worsley (McGill).

Speakers: Mirza I. Beg (Hyderabad & Concordia), Felix Carbonell (Institute for Cybernetics, Mathematics & Physics (Havana, Cuba)), Moo K. Chung (Wisconsin-Madison), Nick Lange (Harvard Medical School), Cyr Émile M'lan (Hospital of Sick Children (Toronto)), Sumitra Purkayastha (Indian Statistical Institute), Jonathan Taylor (Stanford), Yongge Tian (McGill & Queen's).

Statistics Université Laval

Responsible: Louise Chamberland (Laval).

Speakers: Gülhan Alpargu (Massachusetts), David R. Bellhouse (Western Ontario), Cathy Blanchette (Hôpital Saint-Sacrement du centre hospitalier universitaire de Québec), Christian Boudreau (Medical College of Wisconsin), Inna Bumagin (McGill), Judy-Anne Chapman (Women's College Hospital, Toronto), Aurore Delaigle, (California at Davis), Jean-Pierre Dion (UQAM), Charles Dugas (Montréal), Anne-Catherine Favre, (Inst. Natl. de la recherche scientifique - ETE), Marc Fredette (Waterloo), Christian Genest (Laval), El Hadji Guèye (Laval), Serge Guillas (Chicago), Aurélie Labbe (Waterloo), Chantal Labbé (Waterloo), Guy Lacroix (Laval), Fabrice Larribe (McGill), Robert Nadon (McGill), Théophile Niyonga (Centre hospitalier universitaire de Sherbrooke), François Pageau (SNC-Lavallin), Roger Pradel (Centre d'écologie fonctionnelle et évolutive de Montpellier), Jean-François Quessy (UQTR), Meriem Saïd (Laval), Abdessamad Saïdi (Montréal).

PhysNum has the particularity of having been created at the CRM and a great part of its research activity takes place within its walls. This particularity, which contributes to the Centre's visibility within the field of applied mathematics, explains its relatively small size compared to the extent of its collaborations within the milieu of brain imaging in Montréal and elsewhere. PhysNum collaborates with Regroupement Neuro-imagerie Québec (headed by Y. Joannette and J. Doyon), GRENE (headed by F. Lepore, Psychology, Univ. de Montréal), and the group Imagerie Quantitative of INSERM'S Unité 494 in Paris (headed by H. Benali). The greater part of financial resources are invested on student researchers at the CRM. Our research with these groups pertains to mathematical imaging, essentially in medicine, within the following themes:

- Analysis and modeling of wavelets (thermodynamic formalism, graphic models);
- Fractal and multifractal analysis (analysis of materials, angiogenesis, turbulent signals)
- Probabilistic approach to the resolution of inverse problems (maximum entropy inference, independence graphs)

These tools are used in a number of clinical and cognitive domains detailed below. The different teams centred on neurology mentioned above are interested in the development of "fine methods" within their particular research domains and are thus interested in pursuing a longterm relationship

Members of the PhysNum

Directeur

Bernard Goulard (Montréal)
Brain imaging.

Alain Arnéodo (ENS, Lyon)
Fractal and wavelets.

Habib Benali (INSERM, CHU Pitié-Salpêtrière, Paris)
Brain imaging.

Line Garnero (CNRS UPR 640-LENA, Paris)
Magneto-encephalography.

Frédéric Lesage (ART Recherches et Technologies Avancées Inc.)
Conformal theory, integrable systems, inverse problems.

Jean-Marc Lina (Montréal)
Wavelets, statistical modeling and brain imaging, algorithms for statistical learning.

Fahima Nekka (Montréal)
Fractal analysis.

Keith J. Worsley (McGill)
Geometry of random images in medicine and astrophysics.

Maximum d'Entropie et inférence en Magnéto-Encéphalo-Graphie (MEG)

L'étude de l'inférence par maximum d'entropie pour des modèles de mixtures a été poursuivie dans le cadre du problème d'estimation de sources cérébrales en magnéto-encéphalographie. Mise au point dans le travail (**Cécile Amblard, Ervig Lapalme, Jean-Marc Lina**, (2004)), le maximum d'entropie sur la moyenne (MEM) ayant une correspondance avec le formalisme Bayésien; le travail a essentiellement porté sur la version 'Bayésien empirique' du MEM. Ce développement original du MEM permet ainsi de mieux contrôler la loi de référence présente dans le formalisme du MEM. Évalué sur des simulations en MEG à temps fixe, le formalisme continue de démontrer sa stabilité et sa robustesse dans l'estimation des sources dipolaires distribuées (10 000 sources) sur le cortex (**Ervig Lapalme, Jean-Marc Lina, Jérémie Mattout**, (2004)). Dernière étape dans ce volet de recherche, l'estimation des séries temporelles en MEG et l'évaluation des performances du MEM sur des données réelles sont actuellement en cours et font l'objet de la rédaction d'un article (**Ervig Lapalme, Jean-Marc Lina, Bernard Goulard**, (2004)).

Modélisation et inférence entropique sur des arbres multi-échelles

Suite à un séjour de **Jacques Levy-Vehel** (INRIA, Fr.), PhysNum, a accueilli une de ses étudiantes de DEA qui a initié l'étude du principe de maximum d'entropie sur des arbres multi-échelles en ondelettes. L'originalité de ce travail repose sur l'usage des ondelettes complexes dont le groupe s'est fait sa 'marque de commerce' largement reconnue à l'extérieur (**Diego Clonda, Jean-Marc Lina, Bernard Goulard**, (2004)). Ce travail exploratoire (**K. Christophe**, Analyse fractale par ondelettes: application aux mammographies. Rapport de Recherche de DEA, (2003)) a su démontrer une application intéressante dans l'étude thermodynamique du signal en mammographie numérique (modélisation multifractale). Notons que ce contact avec l'INRIA s'est poursuivi avec l'accueil de deux autres étudiants durant l'été 2004. Dans le cadre du travail en analyse fractale, **Fahima Nekka** a, quant à elle, accueilli deux étudiants de l'INRIA et de l'École Centrale de Nantes (Fr.) pour leur programme de recherche en DEA (co-direction avec **Jacques Levy-Vehel** et **Ina Taralova**). Le formalisme multifractal (thermodynamique des signaux) a été appliqué aux images de mammographie numérisées dans le cadre du travail de M.Sc. de **Gaël Sitzia** (co-direction **Bernard Goulard** et **Jean Marc Lina**) qui a mis en place la plateforme logicielle pour effectuer cette analyse. Toujours dans le cadre de l'étude de la mammographie numérisée, on peut souligner le travail d'**Isabelle Guimond** (M. Ing co-dirigée par **Jean-Marc Lina**) sur les foyers de micro-calcifications en imagerie de biopsie stéréo.

Estimateur du signal EEG en présence d'artefacts oculaires

Une des principales difficultés dans l'utilisation de l'électroencéphalographie (EEG) chez les jeunes enfants est la présence, dans le signal, d'artefacts causés par le mouvement oculaire. Ces artefacts sont inévitables et forcent le rejet d'un grand nombre d'acquisitions, réduisant ainsi la portée de l'interprétation des expériences EEG en neuro-pédiatrie. Le problème du filtrage des signaux, afin d'en extraire les artefacts, a été exploré dans la représentation temporelle ou fréquentielle. Au cours de ce projet, nous avons mis au point une approche temps-fréquence en utilisant la représentation en ondelettes continue. La performance de cet algorithme est en cours d'évaluation en milieu clinique.

Localisation de sources en MEG/EEG

L'intégration des informations IRMf (Imagerie de Résonance Magnétique Nucléaire fonctionnelle) dans la détection de sources en MEG/EEG (Magnéto-Electro-Encéphalographie) est l'objectif de ce volet de recherche. L'étude d'une méthodologie d'inférence sur le décours temporel des sources d'un modèle dipolaire distribué, capable de prendre en compte des connaissances a priori multimodales, est actuellement dans sa phase d'évaluation de performance. Le modèle retenu par **Jean Daunizeau** (doctorant en co-tutelle entre l'Université de Montréal et Paris11-Orsay, co-direction **Habib Benali, Bernard Goulard, Jean-Marc Lina**) s'apparente à celui développé dans le cadre du Maximum d'entropie en exprimant la dépendance temporelle à l'échelle de 'parcelles' (construites à partir des données) qui contiennent des sources élémentaires qui sont contrastées localement par la méthode d'inférence (**Jean Daunizeau, Jérémie Mattout, Bernard Goulard, Jean-Marc Lina, Habib Benali**, (2004)). Soulignons que ces méthodes ont fait l'objet d'une évaluation de performance dans un cas clinique bien défini (**Christophe Grova, Jean Daunizeau, Jean-Marc Lina, Habib Benali, Jean Gotman**, (2004)). Cette évaluation terminée, le groupe envisage l'implémentation de la méthodologie dans un environnement de calcul dédié à la multimodalité tel que BrainVisa (développé par Y. Cointepas, CEA, Fr.).

Graphes et Turbulence

Dans le cadre de la thèse de Doctorat de P. St-Jean (P. St-Jean, Statistique de maxima et Modèles graphiques multi-échelles: Application à la turbulence, PhD U. de M, (2003)), l'étude des modèles graphiques associés aux modèles des cascades stationnaires a été menée avec succès. Une des contributions importantes consiste dans la statistique d'ordre introduite par P. St-Jean pour décrire le modèle en cascade appliqué à la turbulence. Ce travail permet d'expliquer pour la première fois le modèle de She-Levesque en turbulence pleinement développée (P. St-Jean, An interpretation of the She-Levesque model based on Order Statistics, à paraître dans Eur. Jour. Phys, (2004)).

Études sur les connectivité et plasticité

Étude dirigée par H. Benali de la plasticité cérébrale par imagerie neurofonctionnelle dans son application à la chirurgie des gliomes de bas grade intra-cérébraux avec G. Marrelec, maintenant au centre RMN (Julien Doyon) et en liaison avec J. Daunizau (étudiant au doctorat en cotutelle Benali-Goulard-Lina) qui travaille sur la localisation et la dynamique des sources de l'activité cérébrale par fusion de données IRM fonctionnelles et EEG. Saad Jbabdi (co-tutelle Benali -Joanette) travaille à la modélisation des connectivités fonctionnelles et anatomiques par imagerie fonctionnelle: application à l'étude des stratégies de la récupération après accident vasculaire ischémique. S. Jbabdi sera au centre RMN à partir de septembre 2004.

Analyse fractale et Modélisation

F. Nekka et ses étudiants ont développé différentes stratégies de traitement et d'analyse de l'information en fonction du degré de complexité du signal étudié. Elle a considéré l'association de l'analyse fractale et d'outils mathématiques classiques dédiés au traitement de l'information. Cette combinaison a permis de palier certaines lacunes des méthodes classiques et ainsi d'élargir leur champ d'application pour tenir compte d'une information à haute résolution et de réaliser des progrès en analyse fractale à l'aide de ces méthodes mathématiques classiques très populaires. Dans ce cadre, elle a récemment mis au point une méthode pratique de l'estimation de la dimension de Hausdorff. La précision de cette méthode dépasse largement celle des techniques habituelles (coll. avec A. Arnéodo, Ecole Normale Sup., Lyon, Fr.). Ces méthodes ont été appliquées à l'extraction de l'information et à la classification de structures poreuses, au-delà des paramètres classiques tels que la porosité et la dimension fractale.

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 2002-2003 or that will be published soon. An asterisk preceding an author indicates that this is a monograph from an Aisenstadt Chair holder.

Recent Titles

AMS: CRM Monograph Series

- D. Schlomiuk, A. A. Bolibrukh, S. Yakovenko, V. Kaloshin & A. Buium, *On Finiteness in Differential Equations and Diophantine Geometry*, (to appear).
- Olga Kharlampovich & Alexei Myasnikov, *Algebraic Geometry for a Free Group*, (to appear).
- Montserrat Alsina & Pilar Bayer, *Quaternion Orders, Quadratic Forms, and Shimura Curves*, vol. 22, 2004.
- Prakash Panangaden & Franck van Breugel, *Mathematical Techniques for Analyzing Concurrent and Probabilistic Systems*, Editors vol. 23, 2004.

AMS: CRM Proceedings & Lecture Notes

- H.E.A Eddy Campbell, David L. Wehlau, *Invariant Theory in All Characteristics*, vol. 35, 2004.
- Hershy Kisilevsky & Eyal Z. Goren, *Number Theory*, vol. 36, 2004.
- P. Tempesta, P. Winternitz, J. Harnad, W. Miller Jr., G. Pogosyan & M. Rodriguez, *Superintegrability in Classical and Quantum Systems*, vol. 37, 2004.
- Jacques Hurtubise & Eyal Markman, *Algebraic Structures and Moduli Spaces: CRM Workshop, July 14-20, 2003*, vol. 38, 2004.

*Publication of the Aisenstadt Chair

Previous Titles

AMS: CRM Monograph Series

- Andrei Tyurin, *Quantization, Classical and Quantum Field Theory and Theta Functions*, vol. 21, 2003.
- Joel Feldman, Horst Knörrer & Eugene Trubowitz, *Riemann Surfaces of Infinite Genus*, vol. 20, 2003.
- *Laurent Lafforgue, *Chirurgie des grassmanniennes*, vol. 19, 2003.
- *George Lusztig, *Hecke Algebras with Unequal Parameters*, vol. 18, 2003.
- Michael Barr, *Acyclic Models*, vol. 17, 2002.
- *Joel Feldman, Horst Knörrer & Eugene Trubowitz, *Fermionic Functional Integrals and the Renormalization Group*, vol. 16, 2002.
- Jose I. Burgos, *The Regulators of Beilinson and Borel*, vol.15, 2002
- Eyal Z. Goren, *Lectures on Hilbert Modular Varieties and Modular Forms*, vol. 14, 2002
- Michael Baake & Robert V. Moody (eds.), *Directions in Mathematical Quasicrystals*, vol. 13, 2000.
- Masayoshi Miyanishi, *Open Algebraic Surfaces*, vol. 12, 2001.
- Spencer J. Bloch, *Higher Regulators, Algebraic K-Theory, and Zeta Functions of Elliptic Curves*, vol. 11, 2000.
- James D. Lewis, *A Survey of the Hodge Conjecture*, 2e Édition (with an appendix by B. Brent Gordon), vol. 10, 1999.
- Yves Meyer, *Wavelets, Vibrations and Scaling*, vol. 9, 1997.
- Ioannis Karatzas, *Lectures on Mathematics of Finance*, vol. 8, 1996.

- John Milton, *Dynamics of Small Neural Populations*, vol. 7, 1996.
- Eugene B. Dynkin, *An Introduction to Branching Measure-Valued Processes*, vol. 6, 1994.
- Andrew M. Bruckner, *Differentiation of Real Functions*, vol. 5, 1994.
- David Ruelle, *Dynamical Zeta Functions for Piecewise Monotone Maps of the Interval*, vol. 4, 1994.
- V. Kumar Murty, *Introduction to Abelian Varieties*, vol. 3, 1993.
- Maximilian Ya. Antimirov, Andrei A. Kolyskin, & Rémi Vaillancourt, *Applied Integral Transforms*, vol. 2, 1993.
- Dan V. Voiculescu, Kenneth J. Dykema, & Alexandru Nica, *Free Random Variables*, vol. 1, 1992.
- Michel Fortin (ed.), *Plates and Shells*, vol. 21, 1999.
- Katie Coughlin (ed.), *Semi-Analytic Methods for the Navier-Stokes Equations*, vol. 20, 1999.
- Rajiv Gupta & Kenneth S. Williams (eds.), *Number Theory*, vol. 19, 1999.
- Serge Dubuc & Gilles Deslauriers (eds.), *Spline Functions and the Theory of Wavelets*, vol. 18, 1999.
- Olga Karlampovich (ed.), *Summer School in Group Theory* (Banff, 1996), vol. 17, 1998.
- Alain Vincent (ed.), *Numerical Methods in Fluid Mechanics* (Montréal, 1995), vol. 16, 1998.
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- John Harnad & Alex Kasman (eds.), *The Bispectral Problem* (Montréal, 1997), vol. 14, 1998.

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- André D. Bandrauk, Michel C. Delfour, & Claude Le Bris (édit.), *Quantum Control: Mathematical and Numerical Challenges*, vol. 33, 2003.
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 - John Harnad & Alexander R. Its (édit.), *Isomonodromic Deformations and Applications in Physics*, vol. 31, 2002
- John McKay & Abdellah Sebbar (eds.), *Proceedings on Moonshine and Related Topics*, vol. 30, 2001.
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 - J. C. Taylor (édit.), *Topics in Probability and Lie Groups: Boundary Theory*, vol. 28, 2001.
 - Israel M. Sigal & Catherine Sulem, *Nonlinear Dynamics and Renormalization Group*, vol. 27, 2001.
 - John Harnad, Gert Sabidussi & Pavel Winternitz (eds.), *Integrable Systems: From Classical to Quantum*, vol. 26, 2000.
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Scientific Personnel

Long-term visitors

Each year the CRM hosts a large number of visitors. The majority come to the centre to participate in scientific activities organized or co-organized by the CRM. In the year 2003-2004, 499 such participants registered for workshops of the thematic program, 796 in activities of the general program and 478 in those of the industrial and multidisciplinary program. In addition, the CRM helped fund several other scientific events. The following list includes only visitors who were in residence for at least four weeks:

Ashot Akhperjanian

Yerevan Physics Institute

Jamil Aouidi

Faculté des Sciences de Bizerte

Dario Bambusi

Università degli studi di Milano

Habib Benali

CHU Pitié Salpêtrière

Yves Bourgault

University of Ottawa

Ligia-Lucia Brinzanescu

Institute of Mathematics "Simon Stoilow"

Vasile Brinzanescu

Institute of Mathematics "Simon Stoilow"

Philippe Caldero

Institut Gérard Desargues

Gianni Cassinelli

Università di Genova

Colin Christopher

University of Plymouth

Walter Craig

McMaster University

Stephan De Bièvre

Univ. des Sciences et Technologies de Lille

Zindine Djadli

Université de Cergy-Pontoise

Vladimir Dorodnitsyn

Keldysh Institute of Applied Mathematics

Victor Enolskii

National Academy of Sciences of Ukraine

Bertrand Eynard

CEA Centre d'études de Saclay

John Friedlander

University of Toronto

André Garon

École Polytechnique de Montréal

Nassif Ghoussoub

University of British Columbia

Piotr P. Goldstein

The Andrzej Soltan Institute for Nuclear Studies

Jaroslav Hlinka

Czech Technical Institute

Yakar Kannai

Weizmann Institute of Sciences

Andrei Kapaev

Russian Academy of Sciences

Jamila Karrakchou

École Mohammadia d'ingénieurs

Iryna Kashuba

Universidade de Sao Paulo

Anatoliy Klimyk

Bogolyubov Institute for Theoretical Physics

Margarita Kraus

Universität Regensburg

Decio Levi

Università di Roma Tre

Michael Levitin

Heriot-Watt University

Dan Mangoubi

Technion Israel Institute of Technology

Luigi Martina

Università di Lecce

Vladimir Matveev

Université de Bourgogne

V. Mikhailov

University of Leeds

Werner Müller

Universität Bonn

Yosuke Ohyama

Osaka University

Shoji Okumura

Osaka University

Abdellatif Ouansafi

Université de Montréal

Yiannis N. Petridis

City University of New York Lehman College

Michael P. Polis

Oakland University

Roman Popovych

National Academy of Sciences of Ukraine

Emma Previato

Boston University

Alexander Pushnitski

Loughborough University

Peter Russell

McGill University

Vardan Sahakyan

Yerevan Physics Institute

Zora Thomova

SUNY-Institute of Technology

Hideaki Ujino

Gunmaa College of Technology

Nicolae Vulpe

Academy of Sciences of Moldova

Clarence Eugene Wayne

Boston University

Eduard Zehnder

ETH-Zentrum

Peter Zeiner

Technische Universität Wien

Eduardo Santillan Zeron

Cinvestav-IPN (Institut Polytechnique National)

Yuanli Zhang

Université de Montréal

Short-term visitors

Visitors who were in residence for less than four weeks:

Alain Arnéodo

C.N.R.S.

Joan Carles Artes

Universitat autonoma de Barcelona

Davide Batic

Universität Regensburg

Habib Benali

CHU Pitié Salpêtrière

Edward Bierstone

University of Toronto

Pieter Blue

Rutgers University

Alexander Bobenko

Technische Universität Berlin

Jochen Brüning

Humboldt-Universität zu Berlin

John P. D'Angelo

University of Illinois, Urbana-Champaign

Lawrence Ein

University of Illinois at Chicago

Miroslav Engliš

Academy of Sciences of the Czech Republic

Felix Finster

Universität Regensburg

Roberto Floreanini

INFN

Peter Forgacs

Université de Tours

Akito Futaki

Tokyo Institute of Technology

Allan Greenleaf

University of Rochester

Jotun Hein

University of Oxford

Willy Hereman

Colorado School of Mines

Eugénie Hunsicker

Lawrence University

Andreas Im Hof

Universität Basel

John Kececioglu

University of Arizona

Jeroen Lamb

Imperial College

Robert Lazarsfeld

University of Michigan

Jeong-Yup Lee

University of Alberta

Frank Lemire

University of Windsor

Ben Lichtin

University of Rochester

John Loftin

Columbia University

Zhiqin Lu

UC Irvine

Toshiki Mabuchi

Osaka University

Rafe Mazzeo

Stanford University

Jeffery McNeal

The Ohio State University

Eckhard Meinrenken

University of Toronto

Richard Melrose

MIT

Alexander Mikhailov

University of Leeds

Pierre Milman

University of Toronto

Mircea Mustata

Clay Mathematics Institute

Thomas Nevins

University of Michigan

Andreea C. Nicoara

Harvard University

Takeo Ohsawa

Nagoya University

Zbigniew Oziewicz

Universidad Nacional Autonoma de Mexico

Wieslaw Pawlucki

Jagiellonian University

Duong H. Phong

Columbia University

Michael P. Polis

Oakland University

Mathieu Raffinot

Université d'Evry

Leslie D. Saper

Duke University

Harald Schmid

Universität Regensburg

Misha B. Sheftel

North Western State Technical University

Alexandre Shnirelman

University of Hull

Jacob Sturm

Rutgers University

Marc Thiriet

INRIA Rocquencourt, Projet M3N

Zora Thomova

SUNY-Institute of Technology

Leopold Vrana

Czech Technical University in Prague

Stephen Wainger

University of Wisconsin-Madison

Gregor Weingart

Universität Bonn

Ben Weinkove

Columbia University

Norman Wildberger

University of New South Wales

Jaroslav Wlodarczyk

Purdue University

Jared Wunsch

Northwestern University

Chan Woo Yang

Johns Hopkins University

Roman Zelazny

Institute of Plasma Physics & Laser Microfusion

Postdoctoral Fellows

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

Alain Bourget

McMaster University

Peter S. Campbell

University of Alberta

Raquel Casesnoves

Université de Montréal

Stéphane Dellacherie

Université de Paris 7

Mostafa Gabbouhy

Université Ibn Tofaïl (Maroc)

David T. Gay

University of California Berkeley

David Gómez-Ullate

Universidad Complutense de Madrid

Alexander Ivrii

Stanford University

Sergei Krutelevich

Yale University

Marcelo Lanzilotta Mernies

Université de la République, (Uruguay)

Vincent Lemaire

Université de Montréal

Jun Li

Université de Montréal

Peter McNamara

Massachusetts Institute of Technology

Marco Merkli

University of Toronto

Ramin Mohammadalikhani

University of Toronto

Brian E. Moore

University of Surrey

Ambrus Pal

Columbia University

Yan Pautrat

Institut Fourier

Alexei V. Penskoi

Université de Montréal

Béla Gabor Puztai

University of Szeged

Mario Roy

University of Göttingen

Anupam Saikia

University of Cambridge

Mohamed Nouredine Senhadji

Université d'Oran

Libor Snobl

Czech Technical Institute

Shannon Lee Starr

University of California

Phi Long Nguyen Thanh

Columbia University

Stephan Tillmann

University of Melbourne

Michèle Suzanne Titcombe

University of British Columbia

Sébastien Tremblay

Université de Montréal

José Manuel Urquiza

Université de Paris 6

Dimiter Vassilev

Purdue University

Alexander Zhalij

Inst. of Mathematics of the National Academy of Sciences, Ukraine

CRM Members in 2003-2004

In contrast with most other mathematics institutes around the world, the CRM can count on the solid foundation of regular, associate and invited members. Regular members are all professors at partner institutions: Université de Montréal, Concordia University, McGill University, UQAM, Université Laval, Université de Sherbrooke and the University of Ottawa. Other members are researchers attached to the CRM in 2003-2004 as part of exchange agreements with neighbouring universities and industry or are long-term visitors from Canadian and foreign institutions. The presence at the CRM of such an active group of researchers has brought many benefits to the centre. In particular, the CRM's national program is greatly facilitated by having on hand a large reserve of willing organizers, who have even contributed financially to the organization of activities. The largest partnership is with the Université de Montréal, which gives the equivalent of five fulltime teaching positions in release time to the CRM. Release agreements with the other Montréal area universities provide for the equivalent of two more full-time positions. Facilities are also provided to researchers attached to junior colleges. Several members are attached to the CRM through industrial agreements.

Here is the list of regulars, associated and invited members of the CRM:

Syed Twareque Ali
Concordia University

Jean-François Angers
Université de Montréal

Vestislav Apostolov
UQAM

Paul Arminjon
Université de Montréal

André D. Bandrauk
Université de Sherbrooke

Line Baribeau
Université Laval

Peter Bartello
McGill University

Liliane Beaulieu
Cégep du Vieux Montréal

Robert Bédard
UQAM

Jacques Bélair
Université de Montréal

Habib Benali
CHU Pitié-Salpêtrière

Yoshua Bengio
Université de Montréal

Anne Bergeron
UQAM

François Bergeron
UQAM

Nantel Bergeron
York University

Marco Bertola
Concordia University

Yves Bourgault
University of Ottawa

Anne Bourlioux
Université de Montréal

Steven Boyer
UQAM

Gilles Brassard
Université de Montréal

Abraham Broer
Université de Montréal

Robert C. Brunet
Université de Montréal

David Bryant
McGill University

Yogendra P. Chaubey
Concordia University

Francis H. Clarke
Claude Bernard Lyon 1

Olivier Collin
UQAM

Robert Conte
CEA Saclay

Octavian Cornea
Université de Montréal

Claude Crépeau
McGill University

Miklos Csürös
Université de Montréal

Chris Cummins
Concordia University

Galia Dafni
Concordia University

Henri Darmon
McGill University

Chantal David
Concordia University

Michel C. Delfour
Université de Montréal

Eusebius J. Doedel
Concordia University

Louis G. Doray
Université de Montréal

Rachida Dssouli
Concordia University

Pierre Duchesne
Université de Montréal

Stéphane Durand
Collège Edouard-Montpetit

Nadia El-Mabrouk
Université de Montréal

Richard Fournier
Dawson College

CRM members in 2003-2004 - continued

Marlène Frigon
Université de Montréal

Martin J. Gander
McGill University

José Garrido
Concordia University

Paul M. Gauthier
Université de Montréal

Eyal Z. Goren
McGill University

Bernard Goulard
Université de Montréal

Andrew Granville
Université de Montréal

Alfred Michel Grundland
UQTR

Richard L. Hall
Concordia University

Michael Hallett
McGill University

John Harnad
Concordia University

Antony R. Humphries
McGill University

Jacques Hurtubise
McGill University

Véronique Hussin
Université de Montréal

Adrian Iovita
Concordia University

Dmitry Jakobson
Université de Montréal

Vojkan Jaksic
McGill University

Niky Kamran
McGill University

Olga Kharlampovich
McGill University

Hershy Kisilevsky
McGill University

Paul Koosis
McGill University

Dmitry Korotkin
Concordia University

Gilbert Labelle
UQAM

Jacques Labelle
UQAM

François Lalonde
Université de Montréal

Robert P. Langlands
Institute for Advanced Study

Christian Léger
Université de Montréal

Dietmar Leisen
Johannes Gutenberg-Universität Mainz

Pierre Leroux
UQAM

Frédéric Lesage
ART Advanced Research Technologies
Inc.

Sabin Lessard
Université de Montréal

Jean LeTourneur
Université de Montréal

Claude Levesque
Université Laval

Decio Levi
Universita' di Roma Tre

Jun Li
Université de Montréal

Jean-Marc Lina
École de Technologie Supérieure

Brenda MacGibbon
UQAM

François Major
Université de Montréal

Vladimir Makarenkov
UQAM

Michael Makkai
McGill University

Patrice Marcotte
Université de Montréal

Javad Mashreghi
Université Laval

Sherwin A. Maslowe
McGill University

Pierre Mathieu
Université Laval

John McKay
Concordia University

Pierre McKenzie
Université de Montréal

Alexei G. Miasnikov
McGill University

Fahima Nekka
Université de Montréal

Nilima Nigam
McGill University

Jiri Patera
Université de Montréal

François Perron
Université de Montréal

Yiannis N. Petridis
City Univ. of New York Lehman College

Iosif Polterovich
Université de Montréal

Ravi Ramakrishna
Cornell University

Thomas J. Ransford
Université Laval

Christophe Reutenauer
UQAM

Ivo G. Rosenberg
Université de Montréal

CRM members in 2003-2004 - continued

Christiane Rousseau
Université de Montréal

Damien Roy
University of Ottawa

Roch Roy
Université de Montréal

Peter Russell
McGill University

Gert Sabidussi
Université de Montréal

Yvan Saint-Aubin
Université de Montréal

David Sankoff
University of Ottawa

Dana Schlomiuk
Université de Montréal

E. J. P. Georg Schmidt
McGill University

Abdellah Sebbar
University of Ottawa

Elisa Shahbazian
Lockheed Martin Canada

Ron J. Stern
Concordia University

Francisco Thaine
Concordia University

John A. Toth
McGill University

Pierre Valin
Defence R & D Canada - Valcartier

Carolyn M. Van Vliet
University of Miami

Luc Vinet
McGill University

Pavel Winternitz
Université de Montréal

Daniel T. Wise
McGill University

Keith J. Worsley
McGill University

Jean-Paul Zolésio
INRIA

Two Committees Heading the CRM

Bureau de direction

The Bureau consists of members from the Université de Montréal (eight to eleven members) and from the outside (two to five members). The rector of the Université de Montréal and the Dean of its Arts and Sciences faculty are represented on the Bureau. The Bureau adopts the policies of the Centre, recommends the nomination and the promotion of researchers and the appointment of regular members, advises the Director on the preparation of the budget and the Université de Montréal on the choice of the Director.

Yoshua Bengio
Université de Montréal

François Bergeron
UQAM

Alain Caillé
Vice-recteur à la recherche,
Université de Montréal

Antony Humphries*
McGill University

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

Hershy Kisilevsky
Concordia University

Jean LeTourneux*
Université de Montréal

Christian Léger
Université de Montréal

Patrice Marcotte*
Université de Montréal

Christiane Rousseau
Université de Montréal

Peter Russell
McGill University

Yvan Saint-Aubin
Université de Montréal

*Deputy directors are invited to meetings as observers.

Scientific Advisory Committee

The Scientific Advisory Committee is constituted of distinguished researchers from Canada and abroad. Its members are either mathematicians or scientists with close ties to the mathematical sciences. The rector of the Université de Montréal and the Director of the CRM attend the meetings of the Scientific Advisory Committee. 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 de direction.

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



Nigel HITCHIN is Savilian Professor of Geometry at New College, Oxford University. He holds a Ph.D. degree in Mathematics (1972) from Wolfson College of Oxford University. He is principally interested in differential and algebraic geometry and its relationship with the equations of mathematical physics. Current projects include the areas of hyperkähler geometry, special Lagrangian geometry and mirror symmetry, geometric solutions of Painlevé equations, magnetic monopoles, vector bundles on algebraic curves, and the theory of gerbes.



Peter GLYNN is Thomas W. Ford Professor in the School of Engineering at Stanford University. He received his Ph.D. in Operations Research from Stanford University in 1982. He is a Fellow of the Institute of Mathematical Statistics and his research interests focus on computational probability, queueing theory, statistical inference for stochastic processes, and stochastic modeling.



Richard LOCKHART is a Professor at the Department of Statistics and Actuarial Science of Simon Fraser University. He received a B.Sc. in Mathematics from the University of British Columbia (1975) and degrees in Statistics from the University of California, Berkeley (M.A., 1976, Ph.D., 1979). He was President of the Statistical Society of Canada in 1996-1997. Much of his work is in the area of model assessment, generally in the form of goodness-of-fit.



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



Mitchell LUSKIN is a Professor of Mathematics at the University of Minnesota, a Fellow of the Minnesota Supercomputing Institute and a member of the graduate faculty of the Department of Aerospace Engineering and Mechanics of the University of Minnesota. He holds degrees in Mathematics from Yale University (B.Sc., 1973) and the University of Chicago (M.Sc., 1976, Ph.D., 1977). His research interests include numerical analysis, scientific computing, applied mathematics, partial differential equations, computational materials science, and computational physics.



Ram MURTY est professeur titulaire de mathématiques et Queen's Research Chair à l'Université Queen's. Il est diplômé de MIT (Ph.D., 1980). Un spécialiste de la théorie des nombres algébrique et analytique, ses recherches portent sur la conjecture d'Artin, les courbes elliptiques, les formes modulaires, les formes automorphes, le programme de Langlands, les conjectures de Selberg, les méthodes de crible et la cryptographie.



Peter B. SHALEN is a Professor at the Department Mathematics, Statistics and Computer Science at The University of Illinois at Chicago. He received his B.A. from Harvard College (1966) and his Ph.D. from Harvard University (1972). He also spent a year as an undergraduate at École Normale Supérieure in Paris. His main research interests are 3-dimensional topology, hyperbolic geometry, and geometric and combinatorial group theory.



Carl POMERANCE is a Professor at the Department of Mathematics of Dartmouth College. From 1999 to 2003, he was a member of the technical staff of Bell Labs-Lucent Technologies. He holds degrees from Brown University (B.A., 1966) and from Harvard University (M.A., 1970, Ph.D., 1972). A number theory specialist, he has received numerous prizes and awards including the Levi L. Conant Prize of the American Mathematical Society.



Steven ZELDITCH is a Professor of Mathematics at Johns Hopkins University. He received his Ph.D. from the University of California, Berkeley, in 1981. His research centers around applications of microlocal analysis to problems concerning: asymptotics of eigenfunctions/eigenvalues on Riemannian manifolds, statistical algebraic geometry, problems of mathematical physics ranging from quantum chaos to 2D Yang-Mills to string/M theory.



Alain Caillé, Vice-Principal (Research), Université de Montréal, **Christian Léger**, CRM Acting Director, and **Christiane Rousseau** was President of the Canadian Mathematical Society from 2002-2004. are ex-officio members of the Advisory Committee.



Alain Caillé



Christian Léger



Christiane Rousseau

Personnel 2003-2004

The Director's Office

Christian Léger	Director by interim
Tony Humphries	Deputy Director, Scientific Program
Patrice Marcotte	Deputy Director, MITACS
Jean LeTourneur	Deputy Director, Publications
Diane Poulin	Secretary

Administration

Vincent Masciotra	Head of Administration
Michèle Gilbert	Administrative Assistant
Muriel Pasqualetti	Administrative Assistant
Guillermo Martinez-Zalce	Research Laboratories Administrative Coordinator
Diane Brulé-De-Filippis	Secretary
Josée Simard	Secretary

Scientific Activities

Louis Pelletier	Coordinator
Josée Laferrière	Assistant Coordinator

Computer Services

Daniel Ouimet	Systems Administrator
André Montpetit	Office Systems Manager (1/2 time)

Publications

André Montpetit	TeX Expert (1/2 time)
Louise Letendre	Technician

Communications

Suzette Paradis	Communications Officer & Webmaster
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	NSERC-Centre	FQRNT-Centre	CÉDAR UdeM	Other universities	MITACS-Centre	ncm ₂	Endowments	Other sources	TOTAL
<u>National Program on Complex Data Structures (NPCDS)</u>									
Workshop on Stat. Methods for CDS	6 366	-	-	-	-	-	-	-	6 366
RESEARCH LABORATORIES PROGRAM	-	22 500	-	36 500	-	-	-	-	59 000
Course releases	-	21 274	-	61 000	-	-	-	-	82 274
Administration and research support	95 168	-	29 167	52 500	-	-	-	-	176 834
PDFs	19 000	-	29 325	22 200	-	-	-	-	70 525
Students	-	4 306	-	36 558	-	-	-	-	40 864
Visitors	7 875	3 315	80	26 799	-	-	-	2 348	40 417
Workshops and seminars	-	-	-	15 455	-	-	-	-	15 455
Other	-	-	-	-	-	-	-	-	-
Total Laboratories	122 043	51 395	58 572	251 013	-	-	-	2 348	485 369
<u>Other Scientific expenditures</u>	-	8 480	-	-	-	-	-	0	8 480
College researchs' projects	-	-	-	-	-	-	-	-	-
UdeM professors	-	-	474 560	-	-	-	-	-	474 560
PDFs	102 599	-	-	30 000	-	-	-	393 595	526 194
Visitors	15 445	-	-	-	-	-	-	12 809	28 254
Students	2 000	-	125	-	-	-	-	50 766	52 891
Associate researchers	-	-	13 411	-	-	-	-	13 406	26 817
Course releases	-	-	-	-	-	-	12 500	-	12 500
Scientific Advisory Committee	2 080	5 060	-	-	-	-	-	1 505	8 646
Publicity, Bulletin, Annual Report, Café Labbé	2 755	-	5 433	-	-	-	-	2 618	10 807
<u>Total other scientific exp.</u>	124 879	13 540	493 529	30 000	-	-	12 500	474 700	1 149 148
<u>Support staff</u>	267 385	187 913	189 118	-	43 519	20 000	-	46 699	754 635
<u>Executive</u>	-	10 934	26 422	-	-	-	-	-	37 356
<u>Other admin. expenditures</u>	-	-	-	-	-	-	-	-	-
Operating expenses	18 068	6 706	8 135	-	811	-	-	11 513	45 234
Computer equipment and software	3 553	1 989	1 147	-	-	-	-	2 974	9 663
Publications, direct costs	-	-	-	-	-	-	-	4 424	4 424
<u>Total other admin. exp.</u>	21 621	8 695	9 282	-	811	-	-	18 911	59 321
EXPENDITURES	1 008 809	297 168	784 159	281 013	98 519	20 000	34 172	772 867	3 296 708
YEAR-END BALANCE	14 291	202 832	51 841	6 787	(13 977)	-	(14 362)	(162 329)	85 083

Mission of the CRM

The Centre de recherches mathématiques (CRM) was created in 1969 by the Université de Montréal through a special grant from the National Research Council of Canada. It became an NSERC national research centre in 1984. It is currently funded by NSERC (Natural Sciences and Engineering Research Council), by the Government of Québec through the FQRNT (Fonds québécois de la recherche sur la nature et les technologies), by the Université de Montréal, as well as McGill, du Québec à Montréal, Concordia, Ottawa, Laval universities 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 programs, etc.);
- its general program provides funding for conferences and special events at the CRM and across the country;
- each year it invites, through the Aisenstadt Chair, one or more distinguished mathematicians, to give advanced courses as part of its thematic program;
- it awards four prizes yearly: the CRM-Fields Prize recognizing major contributions to mathematics, the Aisenstadt Prize given for outstanding work done by a young Canadian mathematician, the CAP-CRM Prize for exceptional achievement in theoretical and mathematical physics, and the CRM-SSC Prize for exceptional contributions to statistics in early career;
- it publishes technical reports and about ten books per year. Some of its collections are published jointly with the AMS and with Springer Verlag;
- it has an extensive postdoctoral fellowship program, with more than thirty postdoctoral fellows in place last year, funded either solely by the CRM or in partnership with other organizations;
- it informs the community of its activities through its newsletter, *Bulletin du CRM*, and its web site at www.CRM.UMontreal.CA;
- it participates, with the other two Canadian centres, in groundbreaking national initiatives. One example is the MITACS project (Mathematics of Information Technology and Complex Systems). Another example is the National Program Committee, which provides funding for off-site research activities. Finally, the three institutes contribute financially to the development of the mathematical sciences in the Atlantic provinces through AARMS, and also participate in the National Program on Complex Data Structures jointly with the Canadian statistical community.

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

- the CRM supports research through its eight research laboratories spanning most of the important areas of the mathematical sciences;
- it supports, through partnership agreements, a group of local researchers chosen mainly from departments of mathematics and statistics, but also computer science, physics, economics, engineering, etc.;
- it organizes series of regular seminars and lecture courses on different areas of the mathematical sciences;
- it sponsors joint activities with the ISM (Institut des sciences mathématiques) including the weekly CRM/ISM colloquium, graduate courses offered by distinguished visitors and a program of postdoctoral fellowships;
- it works actively at developing contacts with industry. Its joint activities with liaison and research centres (CERCA, CIRANO and CRIM) and research centres doing applied research (CRT, GERAD and INRS-Télécommunications) led to the creation of the Network for Computing and Mathematical Modelling (*ncm*). NSERC and about twenty partners such as financial institutions, high-tech companies and government agencies fund this network.

The CRM fulfils its national mission by involving the largest possible number of Canadian mathematicians in its scientific programs, both as participants and as organizers. It also supports many events taking place outside Montréal and the Province of Québec. It is recognized worldwide as one of the major institutes in the mathematical sciences.

The director of the CRM is assisted by two managerial structures: the Bureau de direction and the Scientific Advisory Committee. The Advisory Committee is a group of internationally renowned mathematicians from Canada and abroad, who approve scientific programs and thematic years, choose recipients of the Aisenstadt Prize, participate in the selection of the CRM-Fields Prize, and suggest new scientific ventures to explore.