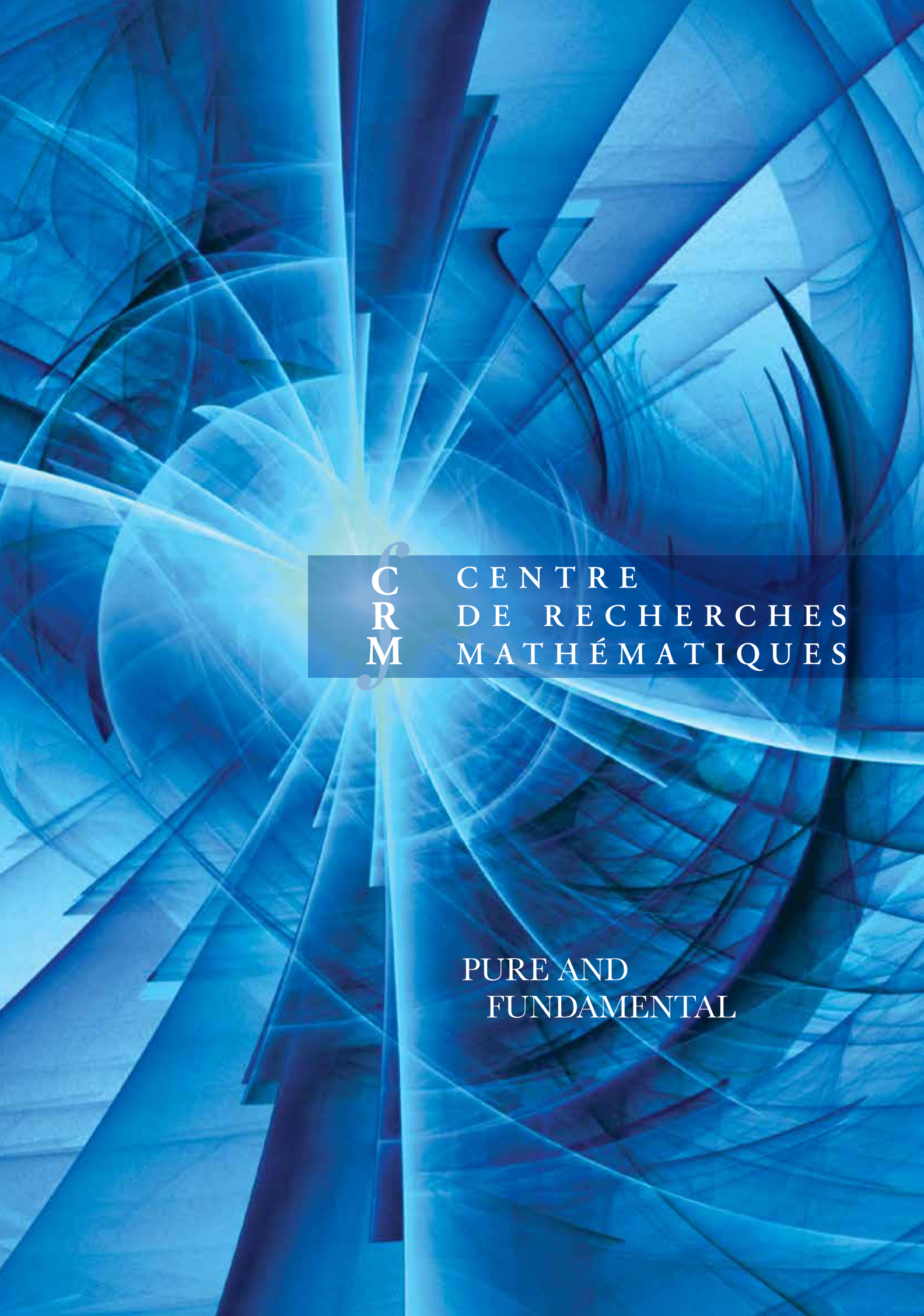
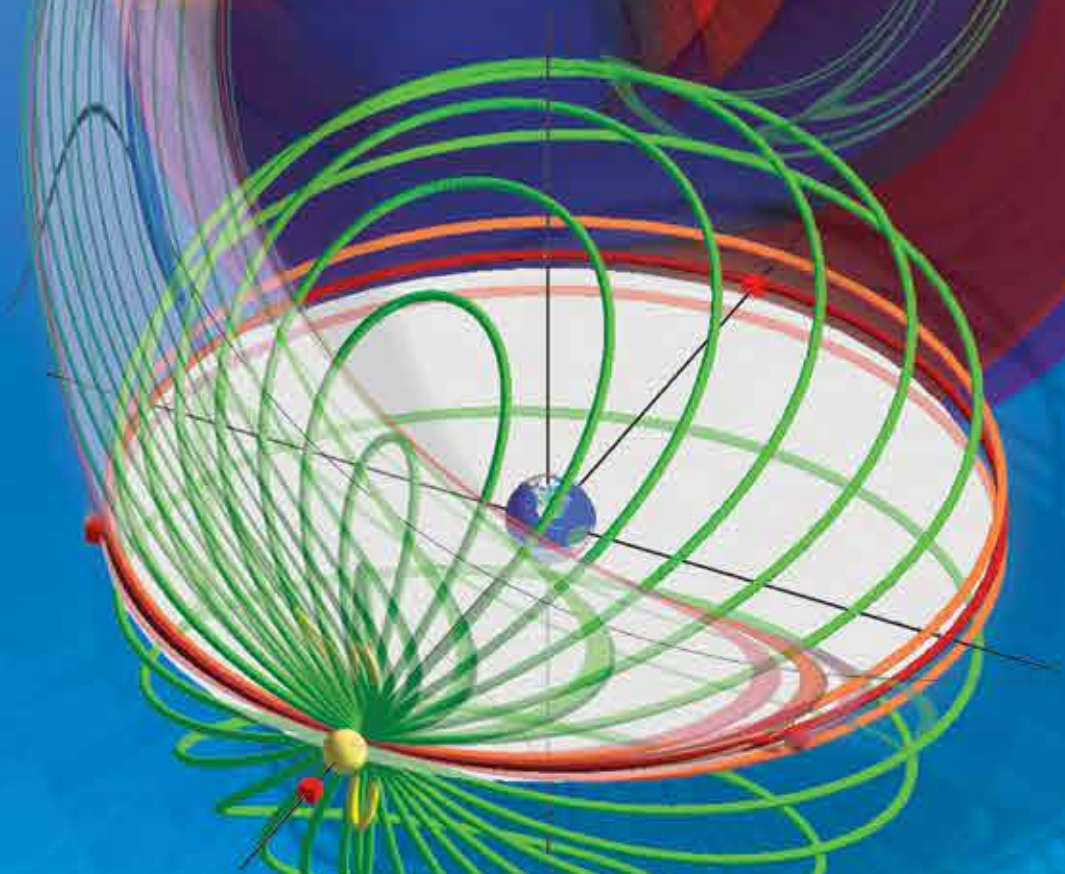
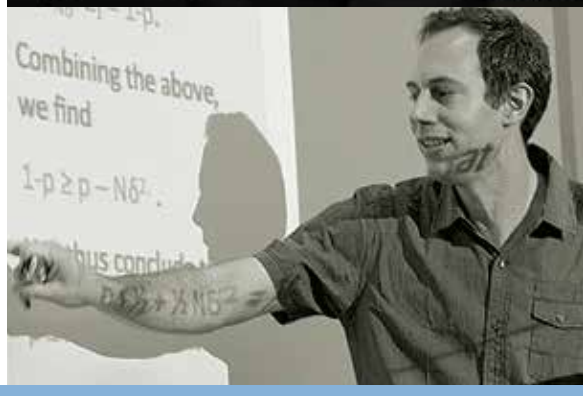

CRM
CENTRE
DE RECHERCHES
MATHÉMATIQUES
PURE AND
FUNDAMENTAL

THE LARGEST RESEARCH CENTRE IN QUÉBEC



The Centre de recherches mathématiques (CRM) is the largest research centre in Québec and one of the most important mathematics research centres in the world. The CRM was created in 1968 at the Université de Montréal and gathers all the stakeholders in mathematical research at Québec universities and some other Canadian universities. The CRM organizes events attended by researchers from all over the globe and representing all mathematical disciplines. The CRM focuses on pure and applied mathematics in all areas of human activity, for instance theoretical physics, brain and molecular imaging, quantum information, statistics, and genomics. Indeed mathematics is both the first science and the servant of experimental science, which draws upon its new concepts, its language, and its methods.

CRSNG NSERC
Fonds de recherche sur la nature et les technologies Québec



A CENTRE WITH MANY PROGRAMS

A bird eye's view of the CRM

The CRM members belong to ten laboratories corresponding to specific mathematical disciplines and including researchers from several universities.

The CRM has many diverse programs; here is an overview of these programs.

Thematic Program

Each semester the CRM chooses a topic at the forefront of mathematical research (in pure or applied mathematics) and organizes workshops and lectures on this topic.

Aisenstadt Chairs

World-renowned mathematicians are invited to give the Aisenstadt Chair lectures, which are usually related to the thematic program of the current semester.

General Program

The CRM organizes and supports financially workshops and conferences in all fields of mathematics.

Multidisciplinary and industrial program

Mathematics are used in all of the sciences and the CRM organizes or supports numerous activities related to non-mathematical sciences and problems arising in industrial, governmental, or medical settings.

Industrial Problem Solving Workshops

Every two years the CRM organizes an Industrial Problem Solving Workshop in order to help solve problems brought forth by companies or public or non-profit organizations.

SMS Summer School

This summer school goes back to 1962 and was financed by NATO over a long period of time. Initially it was organized by the Deparment of Mathematics and Statistics of the Université de Montréal but it is now organized jointly by that department and the CRM. It is one of the oldest and most important scientific schools in the world.

Prizes

The CRM awards prizes either on its own or in collaboration with other mathematical institutes and professional associations such as the Statistical Society of Canada and the Canadian Association of Physicists. In particular the CRM, the Fields Institute, and PIMS jointly award the most important Canadian mathematical prize.

Postdoctoral Scholarships

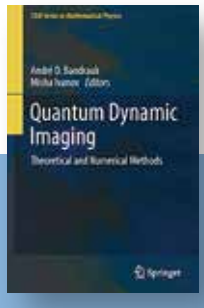
The CRM runs a prestigious program of postdoctoral fellowships in collaboration with the Institut des sciences mathématiques (ISM). This program enables young researchers from all over the world to come to the CRM and work with CRM members.

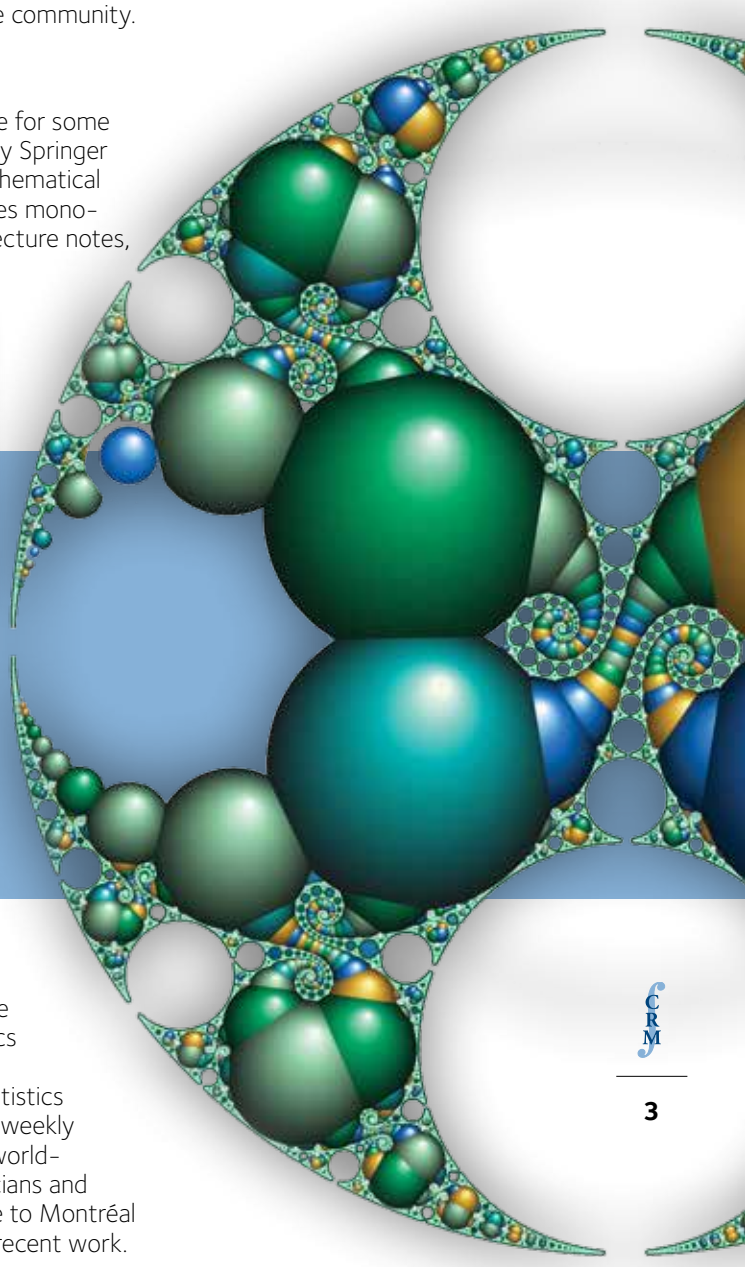
The "Grandes conférences du CRM"

The Grandes Conférences du CRM are lectures geared towards a broad audience and allow the CRM to present to the public the latest advances in mathematics. One goal of these lectures is to develop the scientific culture of the community.

Publications

The CRM is responsible for some collections published by Springer and the American Mathematical Society. It also publishes monographs, proceedings, lecture notes, software, and videos.





Colloquia

The CRM organizes the CRM-ISM Mathematics Colloquium and the CRM-ISM-GERAD Statistics Colloquium. These are weekly colloquia and feature world-renowned mathematicians and statisticians who come to Montréal to present their most recent work.

Mathematics of Planet Earth 2013

The CRM has proposed a wide-ranging program on the Mathematics of Planet Earth, which has been embraced by the most prestigious mathematics institutes in the world.

The CRM thematic program

Each year or each semester, the CRM organizes activities related to a topic at the leading edge of the mathematical sciences.

Each year or each semester, the CRM organizes activities related to a topic at the leading edge of the mathematical sciences.

These activities include workshops, Aisenstadt Chair lectures, and summer schools. They attract hundreds of mathematicians from all over the world and postdoctoral fellowships are offered to young researchers in order to foster collaborations between them and the CRM members. Here are some instances of recent thematic programs.

In 2008-2009 the CRM organized a thematic year on probabilistic methods in mathematical physics. The program included 10 workshops and three series of lectures by Aisenstadt Chairholders (among whom two had been awarded the Fields medal, the equivalent of the Nobel Prize for mathematics).

Many CRM activities pertain to applications of mathematics. The Fall 2009 semester was devoted to medical imaging (used by medical investigators) and quantum imaging (used by researchers in chemistry).

The topics of the first and second semesters of 2010 were respectively number theory and group theory, two branches of pure mathematics that now have many applications in cryptography and theoretical computer science.

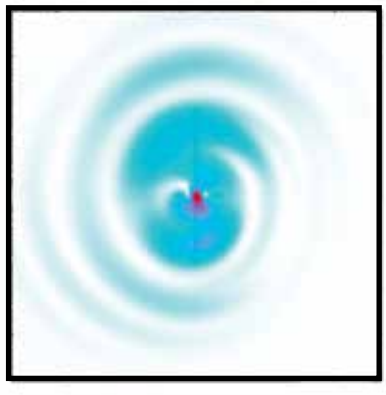
The Winter 2011 semester was devoted to statistics and consisted of 7 workshops, in particular workshops on meteorology, genomics, and health research.

UNDERSTANDING THE LATEST DISCOVERIES

AN ABUNDANCE OF NEW IDEAS

The Spiral Galaxy

The Spinning Electron

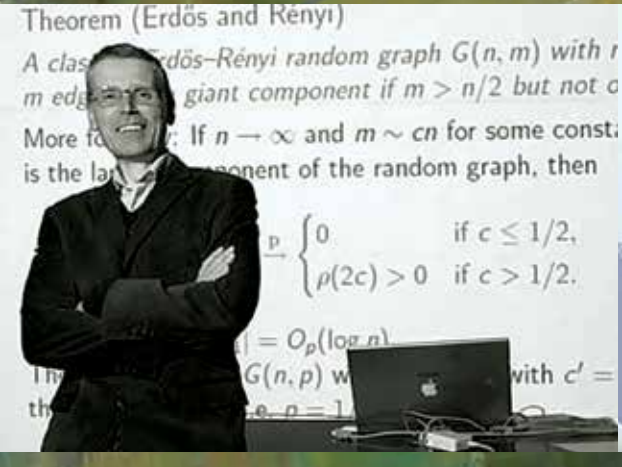


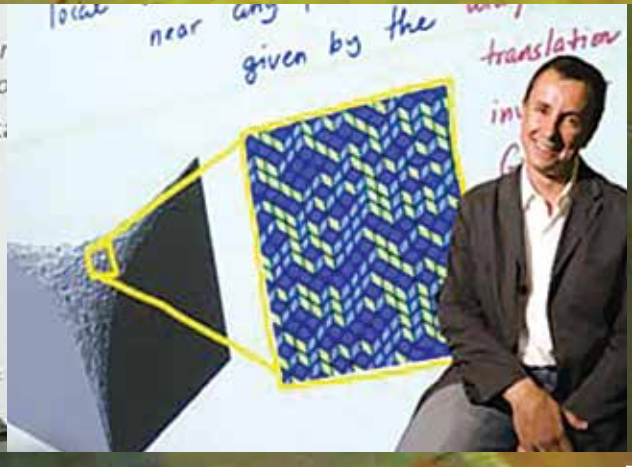
SEMESTRE

Aspects géométriques
nbinatoires et algorithmique
de la théorie des groupe

Juillet
Décembre 201

Centre de recherches mathématiq
Montréal, Ca





CRM

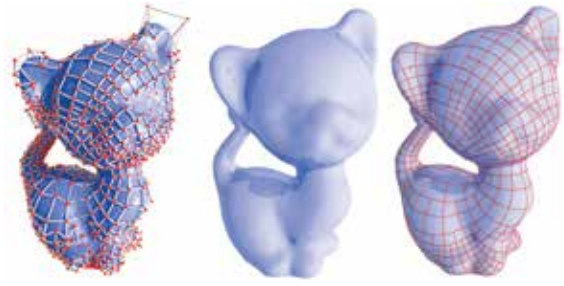
The CRM laboratories

As well as organizing many activities that are international in scope, the CRM brings structure to the research carried out by Québec mathematicians. Almost all Québec researchers in mathematics belong to at least one CRM laboratory.

The members of the **CRM Analysis Laboratory** specialize in a field that is both classical and at the centre of modern mathematics.

The members of **CICMA** (Interuniversity Centre in Algebraic Computation) specialize in algebraic number theory, analytic number theory, group theory, and moonshine.

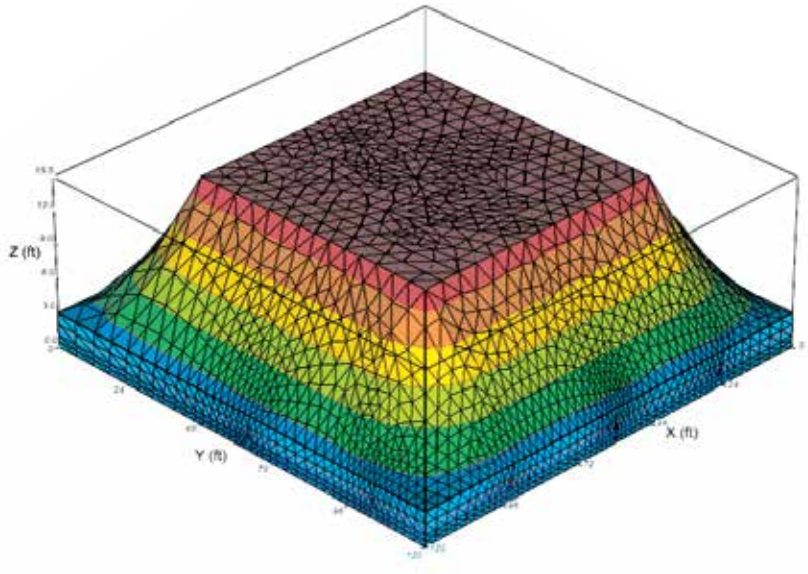
The members of **CIRGET** (Interuniversity Research Centre in Geometry and Topology) are experts in differential geometry, topology, algebraic geometry, and geometric group theory.



© from the web site of David Xianfeng Gu

RESEARCHERS WORKING IN ALL AREAS OF MATHEMATICS

The **GIREF** (Interdisciplinary Research Group in Finite Element Methods) is based at Université Laval in Québec City and its researchers specialize in numerical modelling and simulation and numerical methods, in particular for solving industrial problems.



The **INTRIQ** (Interdisciplinary Institute for Quantum Computing) is an association of researchers who use quantum mechanics in order to solve in novel ways problems arising in computer science and information theory.

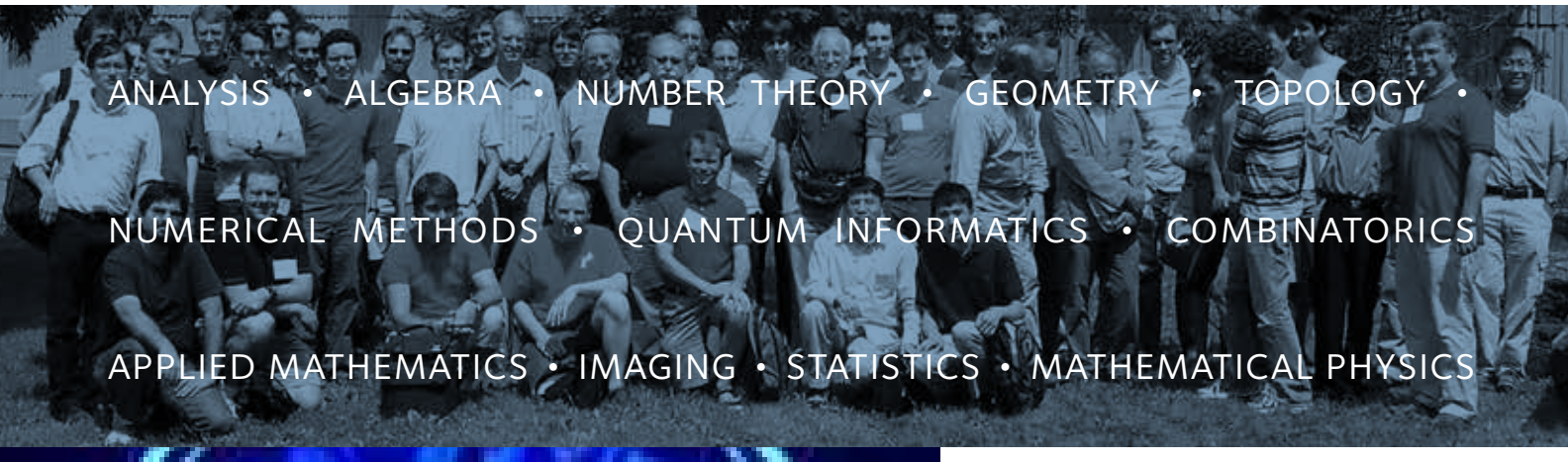
The **LaCIM** (Laboratory of Combinatorics and Mathematical Informatics) was created in 1982 and is based at UQÀM. Its members specialize in enumerative combinatorics, algebraic combinatorics, bioinformatics, and mathematical aspects of computer science.

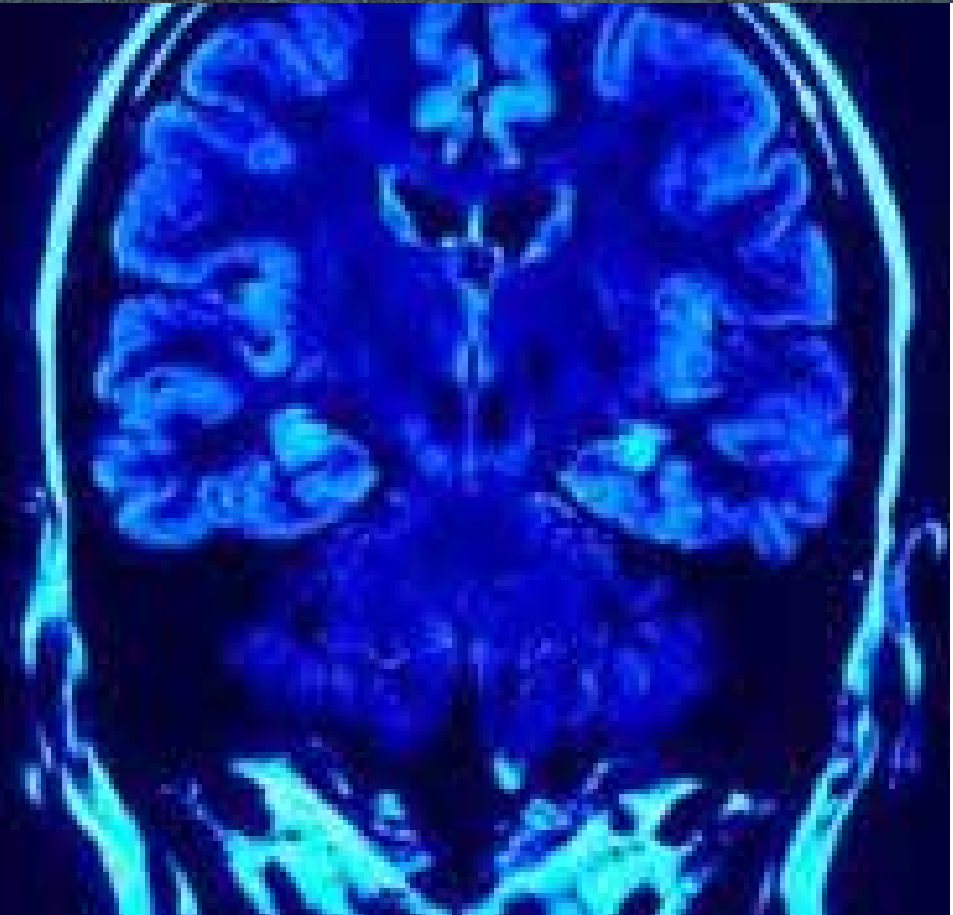
The **Applied Mathematics Laboratory** gathers researchers interested in applications of mathematics (to mechanics of fluids and solids, physics, biology, etc.). Its members use a broad variety of tools, especially tools from optimization, numerical analysis, and dynamical systems.

Ever since the CRM was founded, the **Mathematical Physics group** has been one of its strongest research associations. The mathematicians in the Mathematical Physics Laboratory conduct research in the most up-to-date areas of their field (especially classical and quantum integrable systems, random matrices, conformal field theory, percolation, the spectral theory of Schrödinger operators, and the study of symmetry in difference equations).

The **PhysNum Laboratory** (where "PhysNum" stands for "Numerical Physics") gathers researchers working in medical imaging and pharmacokinetics. Among specific research topics let us mention cerebral activation networks, haemodynamics responses in optical imaging, inverse problems and wavelets, seizure prediction for epileptic patients with implants, metrics to evaluate the clinical impact of variable drug intake behaviour, and pharmacometrics.

The CRM **Statistics Laboratory** gathers statisticians who are leaders in their respective research areas and work in such branches of statistics as statistical learning and neural networks, survey methodology, functional data analysis, statistical image analysis, dependence structures, Bayesian analysis, time series and financial data analysis, and resampling methods.





The CRM Multidisciplinary and Industrial Program

Among members of the CRM one finds researchers from other disciplines who use mathematics and appreciate its contribution to other research fields.

One of these researchers is **André Bandrauk**, who holds the Canada Research Chair in Computational Chemistry and Molecular Photonics at the Université de Sherbrooke. He has just been named an Officer of the Order of Canada. **Yoshua Bengio** and **Gilles Brassard**, both professors at the Université de Montréal, are the respective holders of the Canada Research Chair in Statistical Learning and the Canada Research Chair in Quantum Informatics. In 2009 Gilles Brassard received the Gerhard Herzberg Canada Gold Medal for Science and Engineering (the highest NSERC award).

Since 2007 the CRM has been organizing Industrial Problem Solving Workshops. Companies or other institutions are invited to submit problems that are then modelled, studied, or completely solved by teams consisting of Montréal professors, experts from other cities or countries, and students. These workshops are "incubators" of collaborations between universities and enterprises.

RELATIONS WITH OTHER FIELDS

FOR SOLVING PROBLEMS

TESTIMONY

« The August 2011 Industrial Problem Workshop enabled us to present a framework for estimating the wind resource of an Aeolian Farm to a team consisting of university researchers and students from three universities. Collectively the team members had expertise in statistics, mathematics, and physics. They examined the current methodology in detail and proposed new and original solutions for this concrete engineering problem (a very important one within our industry). The week unfolded in a very friendly atmosphere and the team work was productive and successful. Also we had a great opportunity to learn about and discuss the problems examined by the other teams.

We are grateful to the CRM for having organized an Industrial Problem Solving Workshop. We have much appreciated taking part in the workshop and it has allowed knowledge to be exchanged between industrial and academic representatives. In summary it was a great experiment in industry–university collaboration. »

Michel Carreau, Hatch

Hatch is a professional services firm that delivers a comprehensive array of services to the Mining, Metallurgical, and Energy sectors.

TESTIMONY

In 2009 we were trying to design a method for optimizing dynamic transfer limits in the Hydro-Québec/TransÉnergie high tension network. The workshop allowed us, with the help of a professor and some students, to build an abstract model of our problem and find optimization methods for solving it. At the end of the week a heuristic algorithm had been proposed and two of the students were already working on its implementation. They were interested in pursuing their work and gave us a prototype of the software we needed. The solution implemented at TransÉnergie in 2010 grew directly out of this prototype and is now a basic tool for the engineers who design the network exploitation strategies. The workshop enabled us to make rapid progress and have stimulating exchanges with academic researchers, in a relaxed atmosphere. Our experience was as useful as it was pleasant. We are very happy to have taken part in such a workshop.

Jean-Claude Rizzi and Guy Vanier
Electrical Networks and Mathematics
IREQ, Hydro-Québec Research Institute


André Bandrauk


Yoshua Bengio


Gilles Brassard

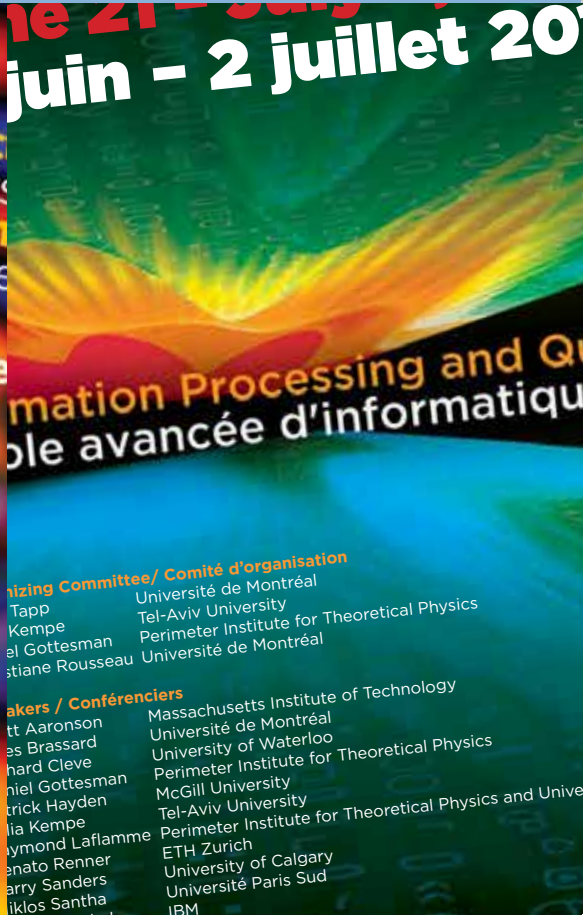
The SMS Summer School and Postdoctoral Fellowships

The SMS Summer School (Séminaire de mathématiques supérieures)

This summer school in pure and applied mathematics has been held for 50 years on the campus of the Université de Montréal. Each SMS is devoted to a topic at the forefront of mathematical research and gathers lecturers of the highest calibre and students from all over the world. These students are mostly graduate students completing their studies. The summer school consists of around 12 minicourses (each of which lasting 5 hours).

The SMS school was created at the request of the Department of Mathematics and Statistics of the Université de Montréal and was originally financed by NATO. Since 2011 the school's principal partner is the CRM but it is also supported by the other Canadian mathematical institutes (the Fields Institute and the PIMS) and by the MSRI (Berkeley, California).

GRADUATE TRAINING AND POSTDOCTORAL FELLOWSHIPS



Postdoctoral Fellowships

The CRM-ISM Postdoctoral Fellowships are very prestigious and selective and they are awarded to carefully chosen researchers. The competition is open to promising researchers from all parts of the world who have obtained recently (or are about to obtain) a doctorate in mathematics. The fellowships are awarded for two years and are financed jointly by the CRM, the ISM, and the CRM laboratories. The CRM also finances up to 50% of the cost of the postdoctoral fellowships associated with thematic semesters.

TESTIMONY

From 2006 to 2009 I was a CRM-ISM postdoctoral researcher at the Centre de recherches mathématiques. These two years were the most productive ones for my research. This was so because I could devote myself entirely to my research and also because many professors, postdoctoral fellows, and visitors were available for fruitful exchanges. The unique Montréal atmosphere and the friendly environment provided by my research group made my stay in Montréal a very pleasant one.

Stefan Friedl
University of Cologne


Antonio Lei


Miljan Brakocevic


Yasha Savelyev

TESTIMONY

My CRM postdoctoral fellowship introduced me into the Montréal "arithmetical" community and an even larger community (thanks to the 2005-2006 Thematic Year on Analysis in Number Theory). The contacts that started during the Thematic Year are very important for me and most of my current projects and collaborations originated during my time as postdoctoral fellow.

Pierre Charollois
Université Pierre et Marie Curie


Cédric Villani

PROMOTING SCIENTIFIC KNOWLEDGE

THE GRANDES CONFÉRENCES

The "Grandes Conférences du CRM"

Delivered by scientists renowned for their communication skills, the "Grandes Conférences du CRM" are geared towards a public eager to understand the most striking developments in the mathematical sciences.

While addressing varied topics (cryptography, quantum information, chaos in weather systems or financial systems, brain imaging, and biotechnology), these lectures all aim to reveal to a broad audience the beauty and power of cutting-edge mathematical research. Here are short descriptions of some of these lectures.

The butterfly effect

The flutter of a butterfly's wings in Brazil may trigger a snow storm in Montréal. This statement captures vividly the consequences of chaos theory. Have mathematics lost their predictive power? Étienne Ghys (from the École Normale Supérieure de Lyon) answered this question by using concrete examples such as the Lorenz Water Wheel and by explaining the power of probabilistic predictions. We were not surprised when Le Devoir (a daily newspaper) devoted its front page to the lecture by Étienne Ghys!

The end of the solar system?

Is a collision between two planets possible? By recalling the efforts made by scientists since Antiquity to answer that question, Jacques Laskar (from the Observatoire de Paris) summed up our knowledge about the stability of the solar system. What may we conclude? Yes, a collision between Mercury and Venus seems possible. Fortunately the probability of such an event (at least within our lifetime) is very small. New simulations by Jacques Laskar, carried out after his lecture at the Université de Montréal, have shown that the Earth itself is not immune from a collision with one of the internal planets.

The laws of disorder

Can mathematical rules describe the disordered motion of molecules jostling together or the percolation of run off water through the soil? The "Grande Conférence" by Yvan Saint-Aubin (from the Université de Montréal) addressed this topic while following an (almost) unpredictable path going from the efforts of Robert Brown (a biologist) to recent advances rewarded by a Fields medal (in 2006). The path also included an excursion through the paintings of Jackson Pollock.

A struggle between titans

In the XIXth century two great British scientists, Charles Darwin and Lord Kelvin, computed the age of the earth. Their conclusions, however, were incompatible. At the time British society followed this debate with passion. The "Grande Conférence" by Cédric Villani (who received a Fields medal in 2010) was a survey of attempts to compute the age of the Earth, a sweeping portrait starting with the oldest documents (e.g., the Book of Genesis in the Old Testament) and ending with recent advances.

Those mathematics have momentum!

Science often gives an edge to top-notch athletes. Can mathematics help golfers too? In his "Grande Conférence" Doug Arnold (from the University of Minnesota) surveyed efforts at devising mathematical models of golf, including the golfer's motion, the impact of the golf club on the ball, the ball's motion, and finally the optimization of the ball surface.

Accromath and the CRM Publications

Accromath is a semi-annual magazine produced by the ISM and the CRM. The magazine is distributed free of charge in the high schools and junior colleges of Québec, as well as in foreign countries. It is mostly geared towards students and teachers in those institutions. On June 15, 2012, Accromath was awarded the Anatole Decerf Prize, a prize that is given every two years by the Société mathématique de France and the Fondation de France to reward exceptional works of popularization or mathematical pedagogy. The panel members stressed the high quality of Accromath, from both the scientific and pedagogic points of view. This event marked the first time that the Anatole Decerf Prize had been awarded to a team not based in France.

WORLD-CLASS PUBLICATIONS

AND OUTREACH TO BUDDING SCIENTISTS

Here are a few of the prizes awarded to Accromath.

SUMMIT AWARDS BRONZE 2007

GRAND GAGNANT 2008 APEX AWARDS FOR PUBLICATION EXCELLENCE

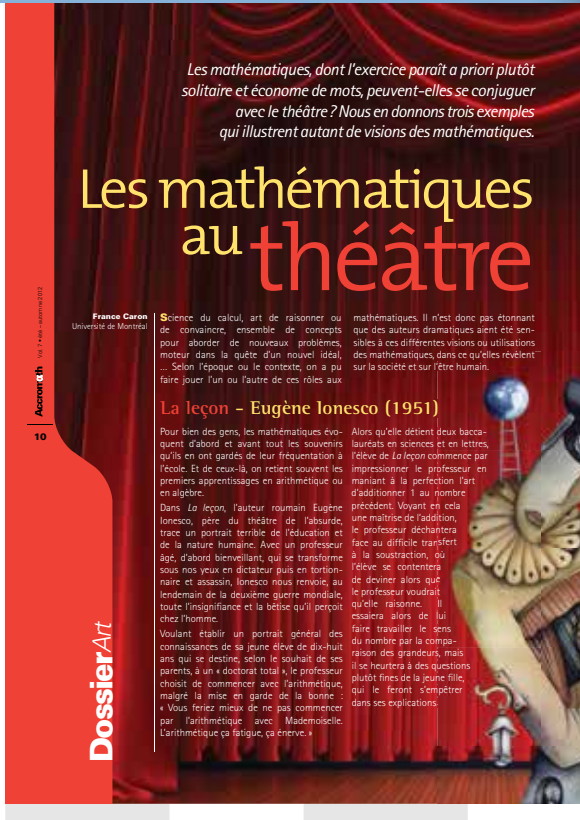
Prix spécial de la ministre 2009
Éducation, Loisir et Sport Québec

SUMMIT AWARDS OR 2010

SUMMIT AWARDS BRONZE 2011

SUMMIT AWARDS OR 2012

Prix Anatole Decerf 2012
Société Mathématique de France SMF



The American Mathematical Society (AMS) has been publishing and distributing two collections of the CRM since 1992, namely the *CRM Monograph Series* and the *CRM Proceedings and Lecture Notes*. These collections include works by prominent mathematicians, some of them Fields medallists. On the other hand Springer publishes and distributes the *CRM Series in Mathematical Physics* and includes some CRM titles in the collection *Lecture Notes in Statistics*. Moreover the CRM publishes and distributes monographs, proceedings, lecture notes, software, and videos (in French or English).

Mathematics of Planet Earth 2013

The CRM proposed the program Mathematics of Planet Earth 2013, which now involves around 100 organizations from all over the world and is one of the greatest scientific enterprises of the beginning of the XXI[st] century.

This program includes the following four themes.

- **A planet to discover**
  oceans, meteorology and climate, mantle processes, natural resources, celestial mechanics
- **A planet supporting life**
  ecology, biodiversity, evolution
- **A planet organized by humans**
  political, economic, social, and financial systems; organization of transport and communications networks; management of resources; energy
- **A planet at risk**
  climate change, sustainable development, epidemics, invasive species, natural disasters

SPECIAL PROGRAMS AND COLLABORATIONS

PLANET EARTH 2013

The **Centre National de la Recherche Scientifique** (CNRS), a French institution, recently created an Unité Mixte Internationale at the CRM. This unit will foster and focus the many relationships that already exist between mathematicians from France and Québec. Professor Laurent Habsieger is the new director of the Unité Mixte Internationale.

Laurent Habsieger


I LIKE THE CRM
Graphic Design: Neograf.ca