Pure and fundamental
THE LARGEST RESEARCH CENTRE IN QUEBEC
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.
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 Department 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 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.
Aspects géométriques, combinatoires et algorithmiques de la théorie des groupes.

Juillet 201-
Décembre 201-
Centre de recherches mathématiques, Montréal, Canada.
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.

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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.

RESEARCHERS WORKING IN ALL AREAS OF MATHEMATICS

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 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.
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
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).
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.

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

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

Antonio Lei
Miljan Brakocevic
Yasha Savelyev
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!

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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 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.
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 XXIst 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

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.
I LIKE THE

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