



CENTRE
DE RECHERCHES
MATHÉMATIQUES

2014
2015

2014-2015 ANNUAL REPORT

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PRESENTATION



LUC VINET

The 2014–2015 thematic programme was devoted to a single (but fundamental) area of mathematics: number theory. The thematic year was entitled “Number Theory from Arithmetic Statistics to Zeta Elements” and organized by the members of CICMA (a CRM laboratory at the leading edge of research in number theory) and Louigi Addario-Berry (member of the Probability Laboratory). I express my heartfelt thanks to the four organizers of this brilliant thematic year: Henri Darmon (McGill University), Chantal David (Concordia University), Andrew Granville (Université de Montréal and University College London), and Matthew Greenberg (University of Calgary). On top of arithmetic statistics (an area of expertise of Montréal mathematicians), the research topics of the thematic year included the rank of elliptic curves, the counting of arithmetic objects, the development of Bhargava’s methods, Kudla’s program, and the gaps between prime numbers, to which James Maynard brought a remarkable contribution. Indeed Maynard, a CRM postdoc supervised by Andrew Granville, proved that there exist an infinity of pairs of consecutive prime numbers such that the gap between the numbers in any pair is at most 600 (see the Bulletin du CRM, Fall 2014). As always the lectures given by the Aisenstadt Chairholders played a key role in the thematic year on number theory: we were honoured to welcome Pierre Colmez (CNRS and Paris 6), Sophie Morel (Princeton), Carl Pomerance (Dartmouth College), and Zeev Rudnick (Tel Aviv), all world leaders in their respective fields. Finally the reader will note that the 2014 SMS Summer School (Séminaire de mathématiques supérieures) formed an integral part of the thematic year since its topic was the counting of arithmetic objects.

The influence of the CRM on the mathematical community is as great as ever thanks to the prizes it awards (on its own or with other institutions) and its outreach to the general public, through the Grandes Conférences du CRM. In 2015 the CRM–Fields–PIMS Prize was awarded to Kai Behrend (University of British Columbia), the André–Aisenstadt Prize to Louis–Pierre Arguin (Université de Montréal), the ACP–CRM Prize (in mathematical physics) to Charles Gale from McGill University, and the CRM–SSC Prize (in statistics) to Matías Salibián–Barrera from the University of British Columbia. The

Grandes Conférences du CRM allowed a wide audience to get acquainted with diverse topics, presented by seasoned mathematicians: “Euler and the Sans–Souci Water Jets” (Yann Brenier), “Measuring Emotional States in Real–Time” (Chris Danforth), “The Antikythera Mechanism: An Astronomical Calculating Machine from Ancient Greece” (James Evans), and “One Thousand Years of Optics, 50 Years of Solitons” (John Dudley).

The Year 2014–2015 was very important from the point of view of the finances and administration of the CRM. During that year the number of laboratories went from nine to twelve, as three research groups became CRM laboratories: CAMBAM (Centre for Applied Mathematics in Bioscience and Medicine), located at McGill; the Probability Laboratory; and Quantact, a laboratory devoted to actuarial and financial mathematics. On June 18, 2014, NSERC announced that it was awarding the CRM a yearly grant of 1,160,500 dollars for the 2014–2019 period. On May 4, 2015, the FRQNT announced that it was awarding the CRM a yearly grant of 408,000 dollars for the 2015–2021 period. Moreover, on July 4, 2014, NSERC awarded the three Canadian mathematics institutes (the CRM, the Fields Institute, and PIMS) a three–year grant amounting to \$1,500,000, within the framework of a new programme called “Institutes Innovation Platform” (IIP). The objective of the IIP is to initiate and foster collaborations between industry and academic researchers in the mathematical sciences; it allowed the CRM to hire a Partnerships Development Officer (Mr. Stéphane Rouillon) and organize a new kind of workshops, called networking events between industry and researchers. Finally, on the international scene, the Unité Mixte Internationale 3457 of the CNRS (located at the CRM and led by Laurent Habsieger) has given an impetus to the relationships between French and Québec mathematicians. The CNRS and FRQNT are even contemplating the creation, in France, of a “mirror site” of this UMI that will host Québec mathematicians working with their French colleagues. To conclude I extend my warmest thanks to all the institutions supporting the CRM, especially NSERC, the FRQNT, the National Science Foundation (United States of America), and the CNRS.

Luc Vinet

Director of the CRM
January 2016

THEMATIC PROGRAMME

NUMBER THEORY FROM ARITHMETIC STATISTICS TO ZETA ELEMENTS

The thematic programme is the most important CRM programme and contributes significantly to its renown and visibility. The theme of the 2014–2015 year was number theory, one of the oldest but also most active fields of mathematics. Indeed, among the seven Millennium problems listed by the Clay Institute, not fewer than three — the Birch and Swinnerton–Dyer conjecture, the Hodge conjecture, and the Riemann hypothesis — were handed down by the Queen of Mathematics. Even by the standards of a subject that has remained vibrant since the days of Fermat and Gauss, the last two decades have witnessed a real golden age, with landmarks too numerous to list completely, such as the striking progress on the Birch and Swinnerton–Dyer conjecture arising from the work of Gross–Zagier, Kolyvagin, and Kato; the proofs of the Shimura–Taniyama–Weil conjecture, Serre’s conjectures, the Fontaine–Mazur conjecture for two-dimensional Galois representations, and the Sato–Tate conjectures that grew out of Wiles’ epoch-making proof of Fermat’s Last Theorem; the revolutionary ideas of Bourgain and Gowers blending techniques in harmonic analysis and additive combinatorics, the Fields–medal winning breakthrough of Green and Tao on primes in arithmetic progressions, and the work of Goldston, Pintz, and Yıldırım, and its spectacular recent strengthenings by Zhang, and Maynard and Tao, concerning bounded gaps between primes. The goal of the 2014–2015 Thematic Year was to take stock of the most recent developments to emerge from this prolonged spate of activity.

One of the most dynamic and penetrating emerging themes (and the most important focus of the special year) was the exciting topic of counting arithmetic objects. Bhargava’s pioneering work led to new and important results on counting elliptic curves with small rank, fields of certain Galois types, counting points on families of higher-genus curves, and so on. The thematic year included a summer school (on the counting of arithmetic objects), seven workshops, four series of lectures by the Aisenstadt Chairholders (Pierre Colmez, Sophie Morel, Carl Pomerance, and Zeev Rudnick), and several courses geared towards doctoral students and postdoctoral fellows. We note that the CRM welcomed around twenty postdoctoral fellows during the thematic year: this is a testimony to the excellent level of the year and the international reputation of CICMA, a CRM laboratory gathering world-renowned experts in algebraic number theory and analytic number theory. The reader will find below summaries of the Thematic Year activities; the Spring 2014 edition of the Bulletin du CRM contains more information on the Thematic Year in general and its Fall 2014 edition more information on the Summer School (“Séminaire de mathématiques supérieures”).

... la conjecture de Fontaine-Mazur et des
r théorème de Fermat; les idées révolutionnaires de
cée de Green et Tao sur les progressions arithmétiques
méliorations spectaculaires apportées par Zhang,
e l’année thématique 2014-2015 sera de faire le bilan

OMBRES,
STATISTIQUE

ANNÉE

ARITH

AUX ÉLÉMENTS

Z

2014 – 2015

CENTRE DE RECHERCHES
MONTRÉAL, QUÉBEC

AIDE FINANCIÈRE
Un appui financier est disponible pour les visiteurs, les boursiers postdoctoraux et les étudiants des cycles supérieurs désirant visiter le CRM pendant l’année thématique. Toute demande doit être accompagnée d’un curriculum vitae. Les étudiants doivent également joindre une lettre de référence du directeur de recherche à leur demande. Veuillez faire votre demande d’aide financière en ligne via le site web de l’année thématique.

Le financement de ce programme est assuré par les organismes suivants :
RSNG (Canada)
FQRNT (Québec)
Université de Montréal (où est logé le CRM)
Université McGill
Université du Québec à Montréal
Université Concordia
Université Laval
Université d’Ottawa
Université de Sherbrooke

SUMMER SCHOOL

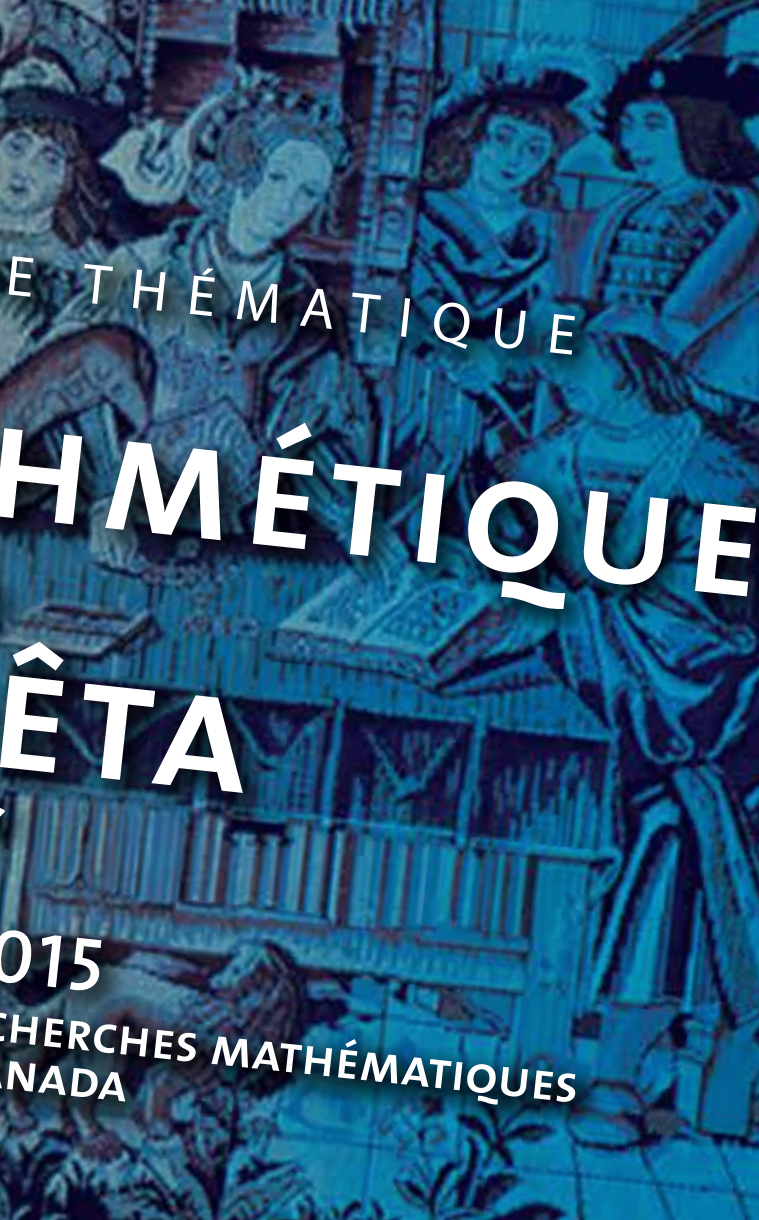
SMS 2015
— SÉMINAIRE DE MATHÉMATIQUES SUPÉRIEURES
COUNTING ARITHMETIC OBJECTS

June 23–July 4, 2014, at the CRM

Sponsored by the CRM, the Fields Institute, PIMS, the MSRI, the ISM, the Université de Montréal, and the CMS

Organizers: Henri Darmon (McGill), Andrew Granville (Montréal), and Benedict Gross (Harvard)

At the beginning of the SMS, more than 50 years ago, the summer school was sponsored by NATO and organized by the Department of Mathematics and Statistics of the Université de Montréal. As time went by, the association between the CRM and the SMS became stronger and stronger. The SMS is not sponsored by NATO any more: its support comes from the CRM, the Fields Institute, PIMS, and the Mathematical Sciences Research Institute (MSRI) at Berkeley. Focused on the celebrated work of Manjul Bhargava, who was himself one of the featured lecturers, the 2014 school was an exceptional event for number theory and beyond, with a great contribution to making Bhargava’s breakthroughs accessible to a larger audience. Remarkably this year, many of the speakers, Bhargava in particular, were present for the full two-week period.



THE THÉMATIQUE

ARITHMÉTIQUE

ÉTÉ

2015

RECHERCHES MATHÉMATIQUES
CANADA



ARITHMETIC OBJECTS
EMPIRE D'OBJETS
ARITHMÉTIQUES

Canada

2014

July 2014

Here are the names and affiliations of the instructors and the course titles.

Manjul Bhargava (Princeton)

Introduction and Perspective

How to Count Rings and Fields I, II

Applications to the Birch and Swinnerton-Dyer Conjecture

Future Perspectives

Henri Darmon (McGill)

Curves, Geometric Aspects

Curves, Diophantine Aspects

Jordan Ellenberg (University of Wisconsin–Madison)

Topological and Algebraic Geometry Methods

over Function Fields I, II

Ekhnath Ghate (TIFR)

Basic Algebraic Number Theory

Counting Artin Representations and Modular Forms

of Height One

Eyal Goren (McGill)

Algebraic Groups, Representation Theory,

and Invariant Theory I, II

Andrew Granville (Montréal)

Basics of Binary Quadratic Forms and Gauss Composition

Basic Analytic Number Theory

Benedict Gross (Harvard)

Arithmetic Invariant Theory and Hyperelliptic Curves I, II

Wei Ho (Columbia)

Coregular Spaces and Genus one Curves

Melanie Matchett-Wood (Wisconsin–Madison)

Cubic Rings

Quartic and Quintic Rings

Rings Associated to Binary n -ic Forms, Composition of $2 \times n \times n$

Boxes and Class Groups

Heuristics for Number Field Counts and Applications

to Curves over Finite Fields

Jennifer Park (Michigan)

The Chabauty Method and Symmetric Powers of Curves

Bjorn Poonen (MIT)

Moduli Space of Rings

Selmer Groups and Heuristics I, II

Chabauty Methods and Hyperelliptic Curves

Arul Shankar (Harvard)

Binary Quartic Forms; Bounded Average Rank of Elliptic

Curves

Michael Stoll (Bayreuth)

Rational Points on Curves

Takashi Taniguchi (Kobe)

The Zeta Functions attached to Prehomogeneous Vector

Spaces

Frank Thorne (South Carolina)

Zeta Function Methods

Jerry Wang (Princeton)

Counting Methods over Global Fields

WORKSHOPS

STATISTICS AND NUMBER THEORY

September 15–19, 2014, CRM

Organizers: Chantal David (Concordia), Pär Kurlberg (KTH), and Zeev Rudnick (Tel Aviv)

The goal of the workshop was to explore statistical aspects of various questions in number theory and the latest developments on the subject of “arithmetic statistics.” More than 20 experts from Europe, North America, and Asia gave one-hour lectures on those latest developments. One theme of the workshop was statistics of zeros of classical L-functions (such as the Riemann zeta function), which have been known, since the work of Montgomery, to be very similar to the statistics of eigenvalues of random matrices. It is predicted by the Katz and Sarnak philosophy that, in a suitable limit, the statistics for the zeros in many families of L-functions follow distribution laws of random matrices. This was proven by Katz and Sarnak for several families of L-functions of curves over finite fields, in the limit of large finite fields. The duality between the number field and the function field world is a constant source of inspiration, and the talks presented interrelated new results on distribution questions in those two worlds.

John Keating talked about conjectures obtained from the moments of the Riemann zeta function on the critical line from a purely number-theoretic point of view, inspired by the conjectures obtained from the random matrix model. Lior Bary-Soroker, Dan Carmon, and Alexei Entin discussed generalizations of classical questions of analytic number theory in the function field context. New results on the rank of families of elliptic curves over number fields and function fields were presented by Chris Hall and Daniel Fiorilli. Different aspects of the distribution of zeros of function fields L-functions and the number of points of families of curves over finite fields were discussed by Chantal David, Maosheng Xiong, and Yongqiang Zhao. There were also enlightening talks by Peter Sarnak about the topology of a random real hypersurface, by David Zywina on families of abelian varieties, and by Andrew Sutherland and Alina Bucur on Sato–Tate distributions, and many more. The workshop also included an inspiring lecture series (on analytic number theory for function fields) by Aisenstadt Chairholder Zeev Rudnick.

NEW HORIZONS IN ADDITIVE COMBINATORICS

October 6–10, 2014, CRM

Organizers: David Conlon (Oxford), Andrew Granville (Montréal), Ben Green (Oxford), Laurent Habsieger (CNRS, UMI CRM), and Alain Plagne (École polytechnique, France)

This workshop was very successful at the international level and gathered 61 participants from nine different countries: 23 Canadians, 20 Americans, and 18 Europeans (including seven from France). It was organized in conjunction with the



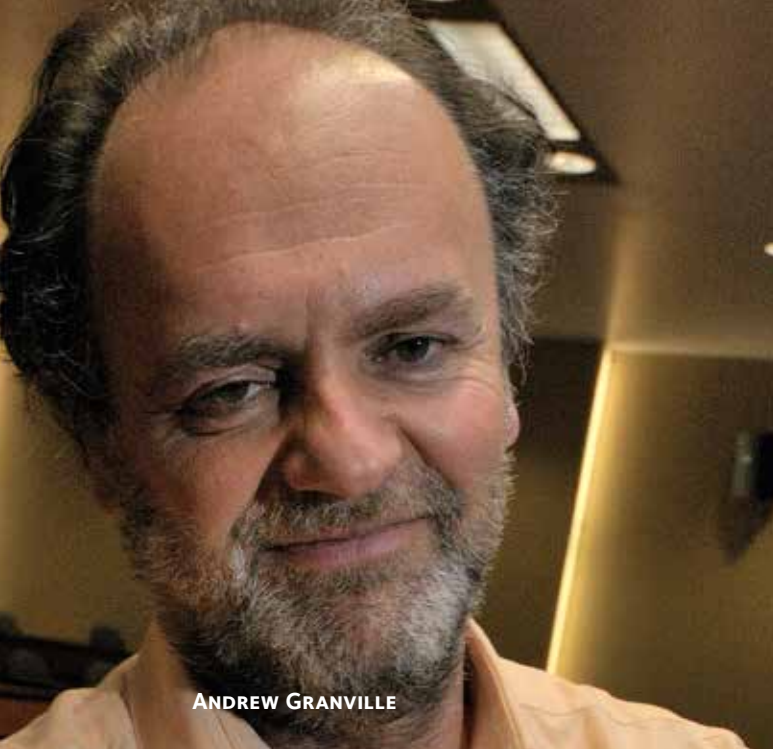
CHANTAL DAVID

Institute for Mathematics and its Applications (Minneapolis), which organized a workshop entitled “Additive and Analytic Combinatorics” (September 29 – October 3). This collaboration between the CRM and the IMA enabled 19 researchers to take part in both workshops.

Additive combinatorics is concerned with counting the number of additive structures within sets. In the past few years this field has grown enormously thanks to its relationships with analytic number theory, ergodic theory, and theoretical computer science. One of the major developments in additive combinatorics is Green–Tao’s theorem on the existence of arithmetic progressions of arbitrary length within the set of prime numbers. The proof of this theorem uses ingredients from analytic number theory as well as the famous theorem by Szemerédi on arithmetic progressions in dense sets. The broad spectrum of applications of the techniques and results from additive combinatorics have a major impact on the way in which mathematicians view many fundamental topics.

The workshop participants use the results of additive combinatorics to explore several questions. Lillian Matthiesen and Nikos Frantzikinakis explained how the theory of uniformity norms due to Gowers can be applied to multiplicative functions; they described its applications to some problems of partition regularity and the counting of rational points on certain algebraic varieties (thus solving cases that could not be solved by traditional methods). Thomas Bloom presented an elegant harmonic analysis result on the structure of the “large spectrum” of a set; he used this result to prove Roth’s theorem on arithmetic progressions of length three with a good bound (this result had been proved by Tom Sanders a few years ago). Schachar Lovett gave a survey of the applications of additive combinatorics to theoretical computer science, especially communication complexity, property testing, and randomness extraction. Indeed several important conjectures (such as the polynomial Freiman–Ruzsa conjecture on the structure of sets with a rich additive structure) arose from these applications to theoretical computer science.

The workshop lasted five days and featured 30 lectures, including a lecture delivered by Alex Kontorovich (Rutgers University) and geared towards a broader audience (within the framework of the Colloque des sciences mathématiques du Québec). Many workshop participants spent fairly long periods of time in Montréal: let us mention Antal Balog (Hungary, one month), Daniel Barrera (one year), Stephan



ANDREW GRANVILLE

Ehlen (Germany, one year), Daniel Fiorilli (Ottawa, 4.5 months), Olivier Fouquet (Orsay, three months), Adam J. Harper (Cambridge, three months), Alastair Irving (Oxford, one year), Robert Lemke Oliver (Stanford, five months), Kaisa Matomäki (Finland, four months), Marc Munsch (Marseille, one year), Jennifer Park (MIT, one year), Maksym Radziwill (Institute for Advanced Study, one year), Fernando Xuancheng Shao (Stanford, two months), Jesse Thorner (Emory, three months), and Yongqiang Zhao (Waterloo, one year).

COUNTING ARITHMETIC OBJECTS (RANK OF ELLIPTIC CURVES)

November 10–14, 2014, CRM

Organizers: Henri Darmon (McGill), Jordan Ellenberg (Wisconsin–Madison), and Andrew Granville (Montréal)

This workshop revolved around the “typical behaviour” of ranks of elliptic curves, but was unusual in that it focused largely on a single breakthrough: the recent theorem of Manjul Bhargava, Chris Skinner, and Wei Zhang proving that a positive proportion of elliptic curves over the field of rational numbers have rank zero and a positive proportion have rank one (and furthermore, that the Shafarevich–Tate groups of these elliptic curves are finite, and that their ranks agree with the order of vanishing of the associated Hasse–Weil L-function at the central point, as predicted by the Birch and Swinnerton–Dyer conjecture). This theorem represents a symbolic landmark, and its proof combines many of the fundamental advances on elliptic curves and the Birch and Swinnerton–Dyer conjecture achieved over the last several decades, growing out of the fundamental work of Gross–Zagier and Kolyvagin on Heegner points, and, more recently: (i) Bhargava’s revolutionary programme for counting arithmetic objects, notably, his work with Arul Shankar counting small order elements in Selmer groups; (ii) the breakthroughs towards the Iwasawa main conjecture growing out of the work of Chris Skinner and Eric Urban and its extension by Xin Wan, and the resulting “converse of Kolyvagin”-type theorems described in the work of Skinner, Venerucci, and Zhang.

The ideas at play in the work of Bhargava, Skinner, and Zhang involve an appealing mix of techniques, from the very analytic (Bhargava’s profound new geometry of numbers arguments and counting methods) to the algebraic (his

methods for parametrizing arithmetic objects of interest via ideas from “invariant theory over \mathbb{Z} ”) and the arithmetic (in the central role played by the Iwasawa main conjecture and by various classical and p -adic Gross–Zagier formulae for counting elliptic curves of rank one). The plan of the workshop reflected the almost “multidisciplinary” nature of the topic being discussed, and a real effort was made to group speakers together according to the different unifying themes. The first day opened with two lecture series of two hours each, by Manjul Bhargava and Eric Urban, covering the “geometry of numbers” and “Iwasawa main conjecture” aspects of the main argument. (Chris Skinner had been originally scheduled to give this lecture series but had to cancel at short notice for family reasons, and it was fortunate that Eric Urban, one of Skinner’s key collaborators in the proof of the Main Conjecture, was able to step in to take his place.) Both lecture series were a great success in conveying the broad outline and key ideas of the proof.

The second day was devoted largely to topics growing out of Bhargava’s revolutionary techniques, with lectures devoted to counting elliptic curves with various extra structures or suggesting heuristics for the behaviours of Selmer groups and Shafarevich–Tate groups modelled on the remarkably successful Cohen–Lenstra heuristics. The third day was devoted to the Euler system techniques used to relate Heegner points with L-functions, both classical and p -adic, and Selmer groups, growing out of the fundamental work of Gross–Zagier and Kolyvagin. Some of the more recent themes covered included the p -adic Gross–Zagier formula of Bertolini–Darmon–Prasanna and the “Johannowitz congruences” explored in the previous decade by Bertolini and Darmon, which are an important ingredient for exhibiting a positive proportion of elliptic curves of rank one independently of the Birch and Swinnerton–Dyer and Shafarevich–Tate conjectures.

The fourth day focused on the fundamental recent results on the Iwasawa Main Conjecture growing out of the work of Skinner and Urban. The techniques involved here are rather different, relying on p -adic families of automorphic forms on unitary groups of signature $(2,2)$ and $(3,1)$. The day concluded with a colloquium lecture by Kartik Prasanna, which aimed to present the overall themes of the entire workshop to colleagues from other mathematical areas. The last day returned somewhat to the themes of the second day, with pivotal lectures by Arul Shankar on the counting of the sizes of 5–Selmer groups of elliptic curves and by Vladimir Dokchitser on the important parity conjecture for elliptic curves. The workshop ended on a high note, with a stimulating and thought-provoking lecture by Bjorn Poonen presenting heuristics that support the belief that the rank of elliptic curves might well be uniformly bounded; this prediction runs counter to a lot of conventional wisdom, although Andrew Granville has arrived at strikingly similar conclusions based on a very different set of considerations. All in all this was an extremely successful, stimulating, and thought-provoking workshop on some of the most fundamental and rapidly evolving questions in number theory.

NEW APPROACHES IN PROBABILISTIC AND MULTIPLICATIVE NUMBER THEORY

December 8–12, 2014

Organizers: Louigi Addario-Berry (McGill) and Dimitris Koukoulopoulos (Montréal)

The workshop featured a fruitful and stimulating mixture of talks, with a wider range of subject matter than at many such workshops: from the probabilistic (Bourgade, Chatterjee, Pemantle) to the analytic and sieve-theoretic talks (Drappeau, Pollack, Luca), and between, beside, and beyond. A unifying theme running throughout the workshop was the blend of probabilistic, analytic, and structural argument pioneered by Paul Erdős; it is an unmistakable marker of his influence on the development of a subject. The workshop also had a diversity of formats. Roughly one third of the session was occupied by three sequences of three lectures each, given by Carl Pomerance, Kannan Soundararajan, and Gérald Tenenbaum (respectively). These three lecture series were a highlight of the workshop.

Carl Pomerance, who held an Aisenstadt Chair, lectured on topics surrounding the sum-of-divisors function, perfect numbers, and amicable numbers. These three lectures included one targeted at and delivered to a general audience, which was well attended and appreciated. Kannan Soundararajan delivered three lectures on zeros and moments of L-functions, describing his joint work with Radziwiłł on upper bounds for small moments, relations to Keating-Snaith analogs of Selberg's central limit theorem, and Harper's refinement of Koukoulopoulos' work on conditional upper bounds for moments of L-functions. Gérald Tenenbaum delivered lectures on three distinct but connected topics. His first lecture concerned the distribution of ultrafriable integers, which are divisible by no prime power exceeding a given limit. His second lecture described his recent proof of Manin's conjecture for Châtelet surfaces, written jointly with La Bretèche, and estimates for the normal order of Hooley's Delta function, obtained jointly with Helmut Maier. His final lecture presented new, uniform asymptotic formulae, obtained recently by Tenenbaum in collaboration with O. Robert for the density of integers with small core (the core of an integer is its largest square-free divisor).

The short talks were also highly stimulating: notable among them were Chatterjee's presentation on the developing theory of non-linear large deviations and Matomäki's talk presenting her recent breakthrough work (in collaboration with Maksym Radziwiłł) on multiplicative functions in short intervals and the resulting progress on the Chowla conjecture. Among the 72 workshop registrants, over half were students or postdoctoral scholars; we were very pleased to obtain such a high degree of involvement from junior participants. The registered participants hailed from 15 countries on five continents, with a plurality from Canada (27).

REGULATORS, MAHLER MEASURE, AND SPECIAL VALUES OF L-FUNCTIONS

February 16–20, 2015

Organizers: Henri Darmon (McGill), Matilde Lalin (Montréal) et Wadim Zudilin (Newcastle)

This workshop was an effort to gather leading mathematicians pursuing a diversity of research programs around the common theme of periods and special values of L-functions. Some of the motivating problems for the workshop were introduced in the first day, which consisted of a combination of talks in Mahler measure and related areas. Zudilin gave the introductory talk, an overview of Mahler measure, with an emphasis on some recent progress that he has made in collaboration with Bertin towards establishing some of Boyd's conjectures for Mahler measure of hyperelliptic curves. Samart then presented his recent results proving that the Mahler measure of certain K3-surfaces can be expressed in terms of elliptic trilogarithms. A lively discussion arose regarding the relation of such results to Zagier's conjectures. The following presentation, by Bertin, involved a description of the Mahler measure problem for multivariable polynomials and included some results on the Mahler measure of two-variable polynomials, leading to special values of Dirichlet L-functions as well as Mahler measures of K3-surfaces. Finally Burgos Gil made a presentation on Arakelov geometry and arithmetic intersection and showed how some Mahler measure formulas arise and could be used to compute intersection numbers. A discussion originated and it became clear that generalized Mahler measure also appears in this way.

The second day revolved around special values of L-functions, both complex and p-adic, and their arithmetic interpretations. Dasgupta described a strategy for proving that certain p-adic L-functions obey the Artin formalism, using p-adic deformations of modular forms in the style of Hida rather than Euler systems. Sands discussed a "tamely ramified" refinement of conjectures on the special values of zeta functions of number fields evaluated at positive integers, simultaneously generalizing the celebrated conjectures of Stark, Mazur-Tate, and Gross. Maillot gave a thought-provoking discussion of some tentative applications of Arakelov geometry to questions of number theory, which would potentially shed light on the construction of Stark units and Stark-Heegner points. Lemma discussed higher analogues of Beilinson elements for Siegel modular threefolds attached to the group $GSp(4)$, and their images under regulator maps, guided by the expected relation between such images and special values of associated L-series.

The third day of the workshop started with some discussions in K-theory. First de Jeu made a presentation in which he described how to construct nontrivial elements in the K_2 of curves. His presentation motivated a discussion on how to express a nontrivial regulator value as a Mahler measure. In the following days some people kept discussing how to relate de Jeu's families to the families studied by Boyd in his conjectures. Some people also discussed the difference between the construction of families with nontrivial regulators in K_2 and similar constructions in K_4 . The second talk was given by Lewis, who discussed how to construct the Bloch cycle class map from simplicial Chow groups to



HENRI DARMON

Deligne cohomology. A discussion arose about the challenges of defining such maps from simplicial Chow groups versus cubical Chow groups. Lewis pointed at some imprecisions in the current literature and a way to correct them. Brunault described some of his ongoing joint work with Chida, which aims to give explicit versions of Beilinson's formula relating complex regulators of Beilinson-Flach elements to values of L-series, while Vlasenko gave a beautiful and far-ranging lecture about point counting for parametrized families of hypersurfaces.

The theme of periods was also present in Fresan's opening lecture on Thursday, which presented a proof of a significant special case of a conjecture of Gross-Deligne (generalizing the formula of Chowla-Selberg), expressing the periods of CM motives in terms of values of the Gamma function at rational arguments. Lee presented historical and recent identities for Rogers dilogarithm from the point of view of conformal field theory. His exposition was an illustration of the power of insights coming from physics in the subject of dilogarithm. The talk ended with some tantalizing questions regarding the extension of such results to higher polylogarithms. Gangl then gave a presentation on Zagier's conjecture for $\zeta(F(3))$ and Goncharov's programme for proving extensions to higher weight by considering certain generalizations of Bloch groups. Gangl then presented some recent results that lead to a first nontrivial functional equation for the tetralogarithm: its geometrical nature suggests that it could play a central role as a generator for the relations of the tetralogarithm (such as the 5-term relation for the dilogarithm and the 22-term relation discovered by Goncharov for the trilogarithm).

Brown gave a presentation that was part of both the workshop and the colloquium. He discussed strategies for irrationality proofs for zeta values (starting from Apéry's result) and gave an insight of his results that explain why irrationality proofs for $\zeta(2)$ and $\zeta(3)$ are expected to be much simpler than for odd values of higher weight. His theory extends to other evaluations of multiple polylogarithms and could lead to future results of irrationality of such special values. The workshop ended with a lecture by Popescu on equivariant L-values, Hecke characters of CM fields, and the K-theory of these fields, and a lecture by Freixas on his ongoing work with Wentworth on a differential Weil reciprocity. Both of these very recent developments seem full of promise.

P-ADIC METHODS IN THE THEORY OF CLASSICAL AUTOMORPHIC FORMS

March 9–14, 2015

Organizers: Henri Darmon (McGill), Matthew Greenberg (Calgary), Adrian Iovita (Concordia), and Payman Kassaei (McGill)

The CRM workshop on p-adic methods was a resounding success, with 86 registered participants, a record for the workshops of the thematic year. This reflects the extremely dynamic and vital state of p-adic arithmetic, which has led to many fundamental breakthroughs in the past decades, starting with Andrew Wiles' epoch-making proof of the Shimura-Taniyama conjecture.

The first talk of the conference was delivered by John Bergdall, who, at the request of the organizers, introduced the young public to the main players of the workshop: p-adic modular forms, Fredholm series, spectral curves, eigencurves and their arithmetic properties. At the same time Bergdall presented recent results and conjectures on the subject (obtained in collaboration with R. Pollack). Next Ruochuan Liu discussed his very interesting and recent proof of the fact that the eigencurve satisfies the rigid analytic valuative criterion for properness at almost all points. The next two talks were given by Benjamin Schraen and Eugen Hellman, who spoke about their joint work on new instances of classicity results for certain unitary groups, using the new techniques introduced by Emerton-Caraiani-Gee-Geraghty-Paskunas-Shin called "patching." The last talk of the first day, given by Abdellah Mokrane, described the recent results of the author together with Olivier Brinon and Jacques Tilouine on a new construction of overconvergent Siegel modular forms using the overconvergence of the Hodge-Tate-Igusa map.

The second day of the conference started with Ruochuan Liu's second talk on a very exciting joint result with Liang Xiao and Daquin Wan, in which they proved R. Coleman's conjecture for modular forms on definite quaternion algebras. Then Vincent Pilloni and Fabrizio Andreatta explained their joint work with A. Iovita on the proof of R. Coleman's conjecture for elliptic modular forms. After lunch Michel Harris discussed his very interesting recent work on the Ichino-Ikeda conjecture and was followed by George Boxer, who explained how to attach Galois representations to certain Hecke eigenforms appearing in coherent cohomology of certain Shimura varieties with good reduction. He could deal with torsion cohomology classes, which seems very interesting.

The next two days of the workshop were dedicated to a group of talks primarily focused on Galois representations and the geometry of Shimura varieties. The first talk was given by Sug Woo Shin, who shared with the audience new results (in collaboration with A. Kret) on the construction of Galois representations attached to regular algebraic cuspidal automorphic representations of general symplectic groups (where simplifying local hypotheses were considered). The next talk was given by Ana Caraiani and focused on a recent work famously due to 6 authors (Caraiani–Emerton–Gee–Geraghty–Paskunas–Shin), where global methods are used to give a definition of a p -adic local Langlands correspondence over a local field different from \mathbb{Q}_p that remains largely mysterious (even after the correspondence has been constructed and well understood over \mathbb{Q}_p). It is worth mentioning that this correspondence is via a functor christened the “Montreal Functor,” so-called after the progress achieved on the subject during a CRM workshop held in 2006.

In contrast to the “global” approach by Caraiani and co-authors via the patching of the completed cohomology, there is a parallel effort of a “local” nature to achieve the correspondence by generalizing the original Φ - Γ construction. The next talk, by Laurent Berger, presented results in line with this approach, where multivariable Lubin–Tate Φ - Γ modules (generalizations of the classical cyclotomic ones) were attached to p -adic Galois representations. In the last talk of the day Jonathan Pottharst presented joint work with Liang Xiao on generalizations of Nekovar’s work on the validity of the parity conjecture for p -adic Galois representations varying in p -adic analytic families.

The next day had a primarily geometric flavour. The first talk was by Kai Wen Lan, the field’s primary expert on compactification of Shimura varieties, who explained to the audience what desirable properties they can expect of compactifications of PEL Shimura varieties obtained by taking normalizations in certain auxiliary good-reduction integral models. Yichao Tian explained work with Shen Xu in which they develop a theory of canonical subgroups for Shimura varieties over which the ordinary locus is empty (as in the work of Harris–Taylor). Benoît Stroh presented joint work with Vincent Pilloni where they use recent work of Scholze to prove the perfectoidness of the toroidal compactification of Siegel varieties at infinite level and prove vanishing results for the completed cohomology in this case. In his talk Jacques Tillouine presented joint work with A. Conti and A. Iovita generalizing to the finite slope case the work of Hida on the big image of the Galois representation for non-CM families of overconvergent p -adic modular forms. This second phase of the workshop concluded with a stimulating colloquium lecture by Aisenstadt Chairholder Pierre Colmez, revolving around the theme of the p -adic upper half-plane and the p -adic Langlands correspondence.

The concluding two days of the workshop were devoted to the arithmetic of Euler systems, in which p -adic methods play an increasingly central role, notably via the explicit reciprocity laws of Coates–Wiles and Kato–Perrin–Riou (which in their modern formulation rely on Fontaine’s theory of p -adic periods of (Φ, Γ) -modules). Guido Kings surveyed some of these key ideas, focusing on the connection with the equivariant Tamagawa number conjecture. Antonio Lei presented some cutting-edge applications of this general circle of ideas, based on p -adic families of Beilinson–Flach elements, a direction that is actively explored and has led to significant recent progress on the Birch and Swinnerton–Dyer conjecture. Carlos de Vera presented an intriguing new construction of Heegner points in the additive reduction case, using uniformizations of elliptic curves by certain finite étale covers of the Drinfeld upper half-plane that had never, until then, been seriously exploited for arithmetic applications of this type. Matteo Longo’s lecture was also devoted to Heegner points, one of the first instances of Euler systems, and the following day Francesc Castella touched upon new cases of the Beilinson–Bloch conjecture. Marco Seveso presented his construction with Marc Masdeu of the quaternionic motives attached to odd-weight modular forms and the workshop concluded with a discussion, by Kazim Buyukboduk, of the “exceptional zero phenomenon” for p -adic L -functions in a non- p -ordinary setting.

THE KUDLA PROGRAMME

April 6–10, 2015

Organizers: Henri Darmon and Eyal Goren (McGill)

The “Kudla Programme” workshop was a tremendously successful activity. On the one hand it was focused enough to present the latest developments in the direction of a set of conjectures and philosophy that became known as the Kudla programme; on the other hand it had enough variation to appeal to non-specialists. One of the highlights of the week was the Colloquium lecture delivered by Steve Kudla, explaining a trajectory beginning with very classical 19th century work on theta functions, continuing with Siegel’s seminal contributions in the mid 20th century, and leading to his own deep contributions (some of which were obtained with Millson, Rapoport, Yang, and others). One could understand in retrospect the hierarchy of generating series he was discussing as a logical next step from the previous state of the art. The future directions he sketched had definitely inspired some of us to pursue them.

One of the initial lectures, by Ulf Kuhn, also contained some ideas proposing a next step in the context of the Kudla programme. An interesting feature of it was the appearance of multiple zeta values that are prominent in the study of periods. Two of our postdoctoral fellows, Stephan Ehlen and Siddarth Sankaran (a former student of Kudla), gave a report in a series of two talks on an important result they had achieved explaining the precise connection between two kinds of Green functions appearing in the literature: Kudla’s Green function and the Borcherds–Bruinier–Funke (also known as automorphic) Green function.

One recurring theme of the programme was the values of Borcherds lifts at CM points, more specifically at the so-called small CM points. From the perspective of putting these in a generating series, we heard several very interesting reports on recent works by Jens Funke and Jan Bruinier. From the perspective of understanding the values themselves, we had the interesting talks by Maryna Viazovska, Keerthi Madapusi Pera, and Fabrizio Andreatta. Jan Bruinier presented a beautiful unification of two important theorems: the Gross-Kohnen-Zagier theorem on modularity of generating series built from values of the j -function (known as singular moduli) and a theorem of Zagier about the modularity of a generating series built from traces of singular moduli. Making use of generalized Jacobians associated to modular curves, he was able to derive each theorem as a consequence of a more general theorem. In a series of two lectures Madapusi Pera and Andreatta reported on the proof of the Bruinier-Yang conjecture and recent progress towards the Bruinier-Kudla-Yang conjecture. This joint work with Ben Howard and Eyal Goren studies the actual values of automorphic Green functions at small CM points; in that sense their work generalizes the work of Gross and Zagier on singular moduli. It has also been applied to the Colmez conjecture about Faltings height of CM points.

Pierre Colmez, one of the Aisenstadt Chairholders for the thematic year, gracefully agreed to give a lecture in place of a cancelled talk. He gave a fascinating insight concerning his long-standing conjecture and we think that many in the audience were hearing for the first time the account of how this conjecture was conceived. In relation to this Andreatta explained how recent work by the above four authors implies a coarse version of the Colmez conjecture, while Jacob Tsimerman explained a sensational breakthrough in which he makes use of this result to deduce the André-Oort conjecture for a large class of Shimura varieties (those of Hodge type). Many other great talks were given during the workshop: Wei Zhang, Eran Asaf, Ehud De Shalit, Gerard Freixas, Ben Howard, Yingjun Li, Yifeng Liu, Jens Funke, Kartik Prasanna, and Jurg Kramer all reported on very exciting developments in a variety of areas related to the Kudla programme. We refer the reader to the Fall 2015 edition of the Bulletin du CRM for more information on these talks.

PAST THEMATIC PROGRAMMES

The Centre de recherches mathématiques (CRM) has organized thematic activities every year since 1993. From 1987 to 1992 the CRM organized various types of activities, including special semesters, concentration periods, and thematic activities.

Here is a list of the main activities organized by the CRM since 1987.

- January–June 2014** Lie Theory
- July–December 2013** Mathematics of Planet Earth 2013 — Thematic Semester on Biodiversity and Evolution
- January–November 2013** Mathematics of Planet Earth 2013 — The Pan-Canadian Program on Models and Methods in Ecology, Epidemiology and Public Health
- January–September 2013** Mathematics of Planet Earth 2013 — International Program in Celestial Mechanics
- 2012–2013** Moduli Spaces, Extremality and Global Invariants
- January–June 2012** Geometric Analysis and Spectral Theory
- June–December 2011** Quantum Information
- January–June 2011** Statistics
- July–December 2010** Geometric, Combinatorial and Computational Group Theory
- January–April 2010** Number Theory as Experimental and Applied Science
- August–December 2009** Mathematical Problems in Imaging Science
- 2008–2009** Joint CRM–PIMS Program: Challenges and Perspectives in Probability
- 2008–2009** Probabilistic Methods in Mathematical Physics
- January–June 2008** Dynamical Systems and Evolution Equations
- June–December 2007** Applied Dynamical Systems
- January–June 2007** Recent Advances in Combinatorics
- June–December 2006** Combinatorial Optimization
- 2005–2006** Analysis in Number Theory
- 2004–2005** The Mathematics of Stochastic and Multiscale Modelling
- 2003–2004** Geometric and Spectral Analysis
- 2002–2003** Mathematics 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 PDEs and Applications (concentration period)
- 1988** Shimura Varieties (special semester)
- 1987** Quantum Field Theory (special semester)
- 1987–1988** Fractals: Theory and Application
- 1987** Structural Rigidity (special semester)

THE AISENSTADT CHAIR

The Aisenstadt Chair was endowed by Montréal philanthropist Dr. André Aisenstadt. Each year one or more distinguished mathematicians are invited to spend at least one week (ideally one or two months) at the CRM. During their stay these mathematicians deliver a series of lectures on a specialized topic. They are also invited to prepare a monograph. At the request of Dr. Aisenstadt, the first lecture given by an Aisenstadt Chairholder should be accessible to a wide audience. Generally speaking the research fields of the Chairholders are closely related to the CRM thematic programmes for the current year.

THE 2014–2015 AISENSTADT CHAIRHOLDERS

Zeev Rudnick is the Cissie and Aaron Beare Chair in Number Theory at Tel Aviv University. He got his Ph.D. from Yale and was an Assistant Professor at Stanford University and Princeton University before joining Tel Aviv University in 1995. Rudnick is a recognized leader in analytic number theory, mathematical physics (especially quantum chaos), and arithmetic statistics, and his work in all those areas is deep and influential. Among the many honours he has received for his research, we mention the Erdős Prize of the Israel Mathematical Union, an Annales Henri Poincaré Distinguished Paper Award, and an ERC Advanced Grant. He has been a Fellow of the American Mathematical Society since 2012 and was an invited speaker at the 2014 International Congress of Mathematicians and the 2012 European Congress of Mathematics.

Professor Rudnick visited the CRM during the workshop on statistics and number theory, which he organized in collaboration with Chantal David and Pär Kurlberg. The reader will find a description of the three lectures he delivered at the CRM in the Spring 2015 edition of the Bulletin du CRM.

Carl Pomerance is the John G. Kemeny Parents Professor at Dartmouth College. He obtained his Ph.D. from Harvard University in 1972. Upon completing his doctoral studies he became a professor at the University of Georgia, where he remained till 1999. He then moved to the Bell Laboratories, where he stayed for four years, before joining Dartmouth College in 2003. Pomerance is a well-recognized leader in number theory, focusing mainly on the analytic, computational, and combinatorial aspects of this vast field. He is also a leading expert on applications of number theory to cryptography, having held for many years the record for the fastest integer factorization algorithm based on the so-called quadratic sieve. Among the many honours he has received for his research, we mention that he is the recipient of the Chauvenet Prize and of the Deborah and Franklin Tepper Haimo Award by the Mathematical Association of America (MAA), and of the Levi L. Conant Prize by the American Mathematical Society (AMS). Moreover he is a fellow of the American Association for the Advancement of Science (AAAS) and the AMS and was an invited speaker at the 1994 International Congress of Mathematicians.



PIERRE COLMEZ

Carl Pomerance visited Montreal twice during the thematic programme: the first time to participate in the workshop on statistics and number theory and the second time for the workshop on new approaches in probabilistic and multiplicative number theory. His Aisenstadt Chair lectures were delivered within the framework of the latter workshop. The reader will find a description of his three lectures in the Spring 2015 edition of the Bulletin du CRM.

Born in 1979 in Issy-les-Moulineaux, **Sophie Morel** studied in Paris at the École normale supérieure and wrote a widely acclaimed Ph.D. thesis in 2005 at the Université Paris-Sud under the supervision of Gérard Laumon. The holder of a Clay Fellowship from 2005 to 2011, she was a member of the Institute for Advanced Study in Princeton from 2006 to 2009 before being appointed Full Professor of Mathematics at Harvard University (becoming the first woman to hold a tenured position in the Harvard Mathematics Department). Since 2012 she has been a Professor at Princeton University. Sophie Morel was invited to deliver an address in the Number Theory section of the 2010 International Congress of Mathematicians in Hyderabad. Her path-breaking work on the cohomology of Shimura varieties and the Langlands programme has also been rewarded with the European Mathematical Society prize for young researchers in 2012, as well as the inaugural 2014 AWM-Microsoft Research Prize in Algebra and Number Theory.





SOPHIE MOREL



CARL POMERANCE



ZEEV RUDNICK

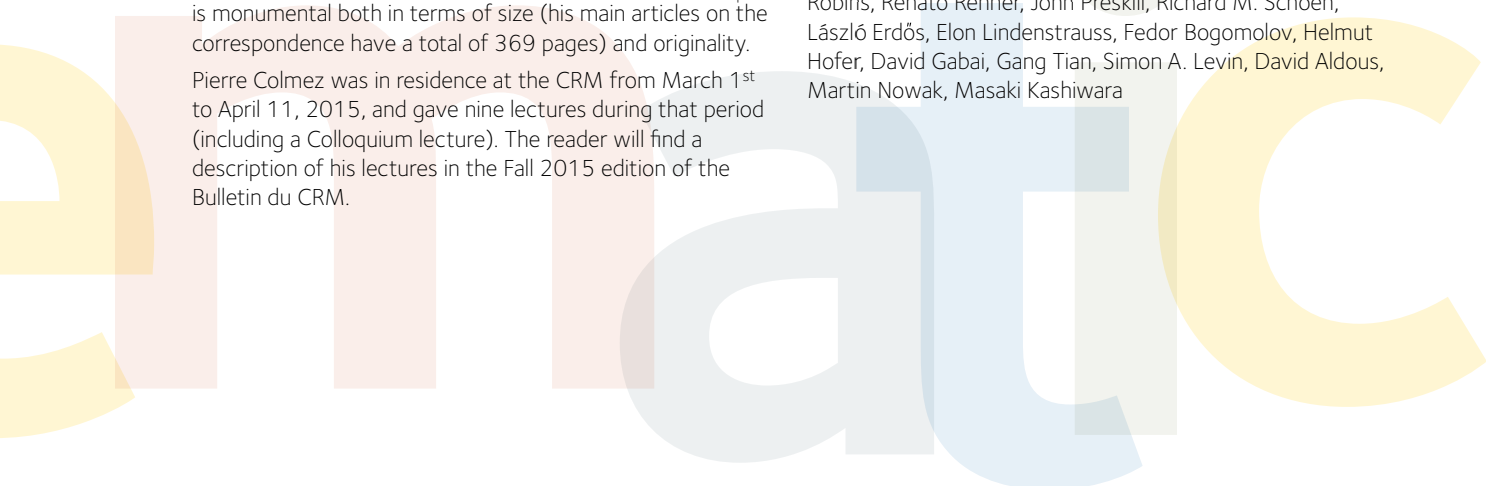
Sophie Morel visited the CRM twice during the thematic year: the first time from February 22 to March 21 and the second time for a two-week period in May. She delivered a series of lectures during each of her visits. The reader will find a description of these lectures in the Fall 2015 edition of the Bulletin du CRM.

Born in 1962, **Pierre Colmez** is a French mathematician and a renowned Go player who has won many medals. Like many of the top French mathematicians, he studied at the École normale supérieure. He earned his Ph.D. at the Université de Grenoble under the supervision of John Coates. He is now a directeur de recherche at the CNRS (Institut de Mathématiques de Jussieu). Colmez' main mathematical contributions were focused in the beginning on p -adic Galois representations and p -adic L-functions, for which he was awarded the Fermat Prize in 2005. Since that period he has focused his efforts on the p -adic Local Langlands Correspondence, an emerging theory whose importance in contemporary Arithmetic Geometry can hardly be overestimated. Colmez' contribution to our complete understanding of the p -adic Local Langlands Correspondence for $GL_2(\mathbb{Q}_p)$ is monumental both in terms of size (his main articles on the correspondence have a total of 369 pages) and originality.

Pierre Colmez was in residence at the CRM from March 1st to April 11, 2015, and gave nine lectures during that period (including a Colloquium lecture). The reader will find a description of his lectures in the Fall 2015 edition of the Bulletin du CRM.

PREVIOUS AISENSTADT CHAIRHOLDERS

Marc Kac, Eduardo Zarantonello, Robert Hermann, Marcos Moshinsky, Sybren de Groot, Donald Knuth, Jacques-Louis Lions, R. Tyrrell 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, Endre Szemerédi, Peter Sarnak, Shing-Tung Yau, Thomas Yizhao Hou, Andrew J. Majda, Manjul Bhargava, K. Soundararajan, Terence Tao, Noga Alon, Paul Seymour, Richard Stanley, John J. Tyson, John Rinzler, Gerhard Huisken, Jean-Christophe Yoccoz, Wendelin Werner, Andrei Okounkov, Svante Janson, Craig Tracy, Stéphane Mallat, Claude Le Bris, Akshay Venkatesh, Alexander Razborov, Angus MacIntyre, Yuri Gurevich, Jamie Robins, Renato Renner, John Preskill, Richard M. Schoen, László Erdős, Elon Lindenstrauss, Fedor Bogomolov, Helmut Hofer, David Gabai, Gang Tian, Simon A. Levin, David Aldous, Martin Nowak, Masaki Kashiwara



OTHER ACTIVITIES

The CRM organizes many activities apart from its thematic programmes: the Séminaire de mathématiques supérieures or SMS (a summer school held in Montréal almost every year since its beginnings in the 1960s and not always related to the thematic programme); short thematic programmes; activities in various fields of the mathematical sciences (the CRM general programme); interdisciplinary and industrial activities; and activities organized by the CRM laboratories. The CRM also sponsors activities that do not take place on its premises and activities organized by other institutions. The reader will find below the main activities organized or sponsored by the CRM in 2014–2015.

SHORT THEMATIC PROGRAMME

CURRENT TOPICS IN MATHEMATICAL PHYSICS

May 1–July 31, 2014, McGill University

Sponsored by the ANR, the CNRS, the CRM, and NSERC

Organizers: Vojkan Jakšić (McGill), Annalisa Panati (McGill), Robert Seiringer (IST Austria), and Armen Shirikyan (Cergy-Pontoise)

This short thematic programme had two objectives: the objective of training (undergraduate or graduate) students and postdoctoral fellows and the objective of gathering world leaders in mathematical physics in order for them to exchange knowledge in an informal fashion and explore new research avenues. The programme consisted of courses and seminars. Here is the list of courses (with the names of instructors within parentheses): “Entropy” (Vojkan Jakšić); “H-theorems out of equilibrium” (Christian Maes); “Dynamical systems” (Yariv Barsheshat); “Gaussian processes and stochastic integration” (Armen Shirikyan); “Hartree–Fock theory” (Marcello Porta); “Heisenberg model” (Alessandro Giuliani); “BSC theory” (Robert Seiringer); “Witten Laplacian” (Bernard Helffer); “Nonequilibrium statistical mechanics of anharmonic chains” (Claude–Alain Pillet); “Adiabatic theorem of quantum mechanics” (Alain Joye); “Quantum dynamical semigroup: stability, invariant structures, and applications” (Francesco Ticozzi); “Conductivity of free fermions” (Laurent Bruneau); and “Introduction to quantization” (Jan Dereziński).

Here is the list of seminars (with the list of speakers within parentheses): “Full counting statistics of return to equilibrium” (Vojkan Jakšić and Annalisa Panati); “Supersymmetric approach to the density of states” (Mira Shamis); “Reflection probabilities for 1D Schrödinger operators” (Vojkan Jakšić); “The SCGO spin jam model, spin waves and combinatorics of tilings” (Israel Klich); “Full counting statistics formulas: from quantum entropy to X-ray absorption” (Israel Klich); “Braiding fluxes in Pauli Hamiltonians” (Joseph Avron); “Lossless compression codes of Lempel–Ziv type” (Ruedi Seiler); “Quasiperiodic operators with monotone potentials” (Svetlana Jitomirskaya); “Memory effects in non-interacting mesoscopic transport” (Horia Cornean); and “Fourier integral operators and WKB approximation” (Jan Dereziński).

THE CRM GENERAL PROGRAMME

The general programme of the CRM funds a wide variety of scientific events, both on the premises of the CRM and elsewhere in Canada. Whether it be for specialized workshops attended by a small number of researchers or large meetings attended by hundreds of participants, the general programme promotes research in the mathematical sciences at all levels. The programme is quite flexible, allowing projects to be considered as they arise.

GENERAL PROGRAMME: ACTIVITIES HELD AT THE CRM

WORKSHOP

COMPUTATIONAL METHODS FOR SURVEY AND CENSUS DATA IN THE SOCIAL SCIENCES

June 20–21, 2014, CRM

Sponsored by CANSSI, the CRM, and SAMSI

Organizers: Mary E. Thompson (Waterloo), Louis–Paul Rivest (Laval), David Haziza (Montréal), Anne–Sophie Charest (Laval), Mike Hidirolou (Statistics Canada), and Jean Poirier (Montréal)

CONFERENCE

EXACT SOLVABILITY AND SYMMETRY AVATARS CONFERENCE HELD ON THE OCCASION OF LUC VINET’S 60TH BIRTHDAY

August 25–29, 2014, CRM

International Advisory Committee: Matthias Christandl (Copenhagen), Charles F. Dunkl (Virginia), Edward Farhi (MIT), John Harnad (Concordia), Mourad E.H. Ismail (Central Florida), Roman Jackiw (MIT), Niky Kamran (McGill), Duong H. Phong (Columbia), Craig A. Tracy (UC Davis), and Oleksiy Zhedanov (Donetsk IPT)

Organizers: Decio Levi (Roma Tre), Willard Miller Jr. (Minnesota), Yvan Saint–Aubin (Montréal), and Pavel Winternitz (Montréal)

Professor Vinet contributed to several different areas of mathematics and physics. His contributions share a common theme, that of symmetries in nature and science. The conference thus brought together scientists who would usually not attend the same event. It turned out that they were all able to communicate easily and fruitfully. Indeed all participants use symmetries, groups, algebras, and their representation theory as everyday tools.

One of Vinet’s earliest research topics was the use of symmetries to study the dynamics of classical and quantum systems. This includes the problems of separation of variables, integrability, and superintegrability, in both continuous and discrete realms. This is currently a very active field of research and several talks were devoted to new developments in this area (A.M. Escobar Ruiz, D. Levi, W. Miller Jr., G. Pogosyan, S. Post, A. Turbiner, and W. Zakrzewski). The study and classification of orthogonal polynomials are an important part of Vinet’s current interests and this field was well represented in the talks (P. Desrosiers, C.F. Dunkl, E. Emsiz,

V. Genest, Y. Grandati, M. Ismail, E. Koelink, T. Koornwinder, L. Lapointe, F. Marcellán, P. Mathieu, D.W. Stanton, J.F. van Diejen, O. Zhedanov). Quantum information theory also makes use of the idea of symmetries. While Vinet has not published many articles in this field, his work has also had an important impact in quantum information. Many leaders of this recent field presented their results (M. Christandl, G. Coutinho, E. Farhi, R. Floreanini). Several other fields were represented, relating various aspects of symmetry and integrability: coherent states (A. Strasburger), differential and spectral geometry (N. Kamran, A.V. Penskoj, K. Tenenblat), cellular automata (H. Ujino), integrable combinatorics (P. Di Francesco, J. Harnad), integrable lattice models (A. Morin-Duchesne), isomonodromy and conformal field theory (A.R. Its), quantum and string theory (E. D'Hoker, R. Jackiw, D.H. Phong), quantum walks (F.A. Grünbaum), and fundamental results in algebras and representation theory (L. Snobl, P.M. Terwilliger).

The celebration provided an ideal occasion for many young scientists to thank Professor Vinet for his mentoring. Several young scientists were among the speakers: Luc Lapointe, Sarah Post, Jan Felipe van Diejen, and Vincent Genest (who is currently completing his Ph.D. under Vinet's supervision). Others acknowledged gratefully the influence of Vinet's seminal ideas on their work, his pregnant questions during talks, and the pleasure of working with him on scientific projects.

CRM-CANSSI WORKSHOP NEW HORIZONS IN COPULA MODELING

December 15–18, 2014, CRM

Sponsored by the CRM, CANSSI, the Statistics Laboratory of the CRM, and the Canada Research Chair in Stochastic Dependence Modelling

Organizers: Fateh Chebana (INRS-ETE), Christian Genest (McGill), and Louis-Paul Rivest (Laval)

WORKSHOP STATISTICAL AND COMPUTATIONAL CHALLENGES IN NETWORKS AND CYBERSECURITY

May 4–8, 2015, CRM

Sponsored by CANSSI, the CRM, and the Tutte Institute

Organizers: Hugh A. Chipman (Acadia) and François Thériège (Ottawa)

24 HEURES DE SCIENCE (10TH EDITION) À LA LUMIÈRE DES MATHÉMATIQUES

May 8, 2015, André-Aisenstadt Pavilion

Sponsored by the CRM, CIRRELT, GERAD, the ncm₂, CIRANO, and the ISM

GENERAL PROGRAMME: ACTIVITIES SUPPORTED BY THE CRM OUTSIDE ITS PREMISES

CONFERENCE THEORY CANADA 9

June 12–15, 2014, Wilfrid Laurier University

Sponsored by the Perimeter Institute, the Fields Institute, the Winnipeg Institute for Theoretical Physics, the Canadian Institute for Theoretical Astrophysics, the Canadian Association of Physicists, Wilfrid Laurier University, Women in Science, the University of Waterloo, the Institute for Quantum Computing, and the CRM

Organizers: Arundhati Dasgupta (Lethbridge), Svetlana Barkanova (Acadia), Shohini Ghose (Wilfrid Laurier), Marek Wartak (Wilfrid Laurier), and Hasan Shodiev (Wilfrid Laurier)

ARTA III — ADVANCES IN REPRESENTATION THEORY OF ALGEBRAS

June 16–20, 2014, UQAM

Sponsored by LaCIM, the CRM, the ISM, the Université de Sherbrooke, and the CNRS

Organizers: Ibrahim Assem (Sherbrooke), Thomas Brüstle (Sherbrooke and Bishop's), Christophe Hohlweg (UQAM), José Antonio de la Peña (CIMAT), Franco Saliola (UQAM), and Andrzej Skowroński (Nicolas Copernicus)

CONFERENCE CNTA XIII — 13TH CONFERENCE OF THE CANADIAN NUMBER THEORY ASSOCIATION

June 16–20, 2014, Carleton University and the University of Ottawa

Sponsored by the CNTA, Carleton University, the University of Ottawa, the CRM, the Tutte Institute, the Number Theory Foundation, the Fields Institute, and the National Science Foundation

Scientific Advisory Committee: John Friedlander (Toronto), Steve Gonek (Rochester), Eyal Goren (McGill), Stephen Kudla (Toronto), Cameron Stewart (Waterloo), Hugh Williams (Calgary & Carleton), and Kenneth Williams (Carleton)

Organizers: Ayse Alaca (Carleton), Saban Alaca (Carleton), Paul Mezo (Carleton), Damien Roy (Ottawa), Abdellah Sebbar (Ottawa), Gary Walsh (Ottawa), Hugh Williams (Calgary & Carleton), and Kenneth Williams (Carleton)

AARMS-CRM WORKSHOP ADAPTIVE METHODS FOR PDES

August 17–22, 2014, Memorial University

Sponsored by AARMS, the CRM, the National Science Foundation, the Department of Mathematics and Statistics of Memorial University, the Faculty of Science of Memorial University, the Office of Vice-President (Research) of Memorial University

Organizers: Ronald Haynes (Memorial), Hermann Brunner (Memorial), and Paul Muir (Saint Mary's)

**CRM–ICMAT WORKSHOP
EXCEPTIONAL ORTHOGONAL POLYNOMIALS
AND EXACT SOLUTIONS IN MATHEMATICAL PHYSICS**

September 7–12, 2014, Segovia

Sponsored by the Spanish Ministry of the Economy and Competitiveness, SIAM, and the Maria Zambrano Campus of the Universidad de Valladolid in Segovia

Organizers: David Gómez-Ullate (ICMAT & Complutense), Francisco Marcellán (ICMAT & Carlos III), and Miguel A. Rodríguez (Complutense)

**QUÉBEC–MAINE NUMBER THEORY
CONFERENCE**

September 27–28, 2014, Université Laval

Sponsored by the CRM, the Fields Institute, the Number Theory Foundation, the National Science Foundation, CICMA, the Department of Mathematics and Statistics of the Université Laval

Organizers: Hugo Chapdelaine, Jean-Marie De Koninck, Antonio Lei, and Claude Levesque (Laval)

**58TH CONGRESS OF THE ASSOCIATION
MATHÉMATIQUE DU QUÉBEC
LES MATHÉMATIQUES, INDISPENSABLES!
DE GALOIS AU MP3**

October 3–4, 2014, Cégep régional de Lanaudière

**CONNECTING WOMEN IN MATHEMATICS
ACROSS CANADA**

October 3–5, 2014, Banff International Research Station

Sponsored by PIMS, the CRM, AARMS, the Fields Institute, and the Chair for Women in Science and Engineering

Organizers: Galia Dafni (Concordia), Sara Faridi (Dalhousie), Shannon Fitzpatrick (Prince Edward Island), Megumi Harada (McMaster), and Malabika Pramanik (UBC)

**SUMM 2015 — SEMINARS IN UNDERGRADUATE
MATHEMATICS IN MONTRÉAL**

January 9–11, 2015, Université de Montréal

Sponsored by the STUDC, the ISM, McGill University, the Université de Montréal, the Arts and Science Federation of Associations (Concordia), the Science Undergraduate Society (McGill), the Association des Étudiants en Mathématiques et Statistique (Montréal), Concordia University, UQAM, the Mathematics, Actuarial & Statistics Student Association (Concordia), the Society of Undergraduate Mathematics Students (McGill), the Association Générale Étudiante en Mathématiques et Actuariat (UQAM), the CRM, and MapleSoft

Organizers: François De L'Isle (Montréal), Gida Hussami (Concordia), David Kleiman (McGill), Joey Litalien (McGill), Marc-André Miron (Montréal), Fabrice Nonez (Montréal), Catherine Poissant (Montréal), Renaud Raquépas (McGill), and Erick Schulz (McGill)

**XVIII^E COLLOQUE PANQUÉBÉCOIS DES ÉTUDIANTS
DE L'INSTITUT DES SCIENCES MATHÉMATIQUES**

May 15–17, 2015, HEC Montréal

Sponsored by the ISM, HEC Montréal, the CRM, the Department of Mathematics and Statistics of McGill University, and the Chaire d'actuariat (Université Laval)

Organizers: Malek Ben-Abdellatif (HEC Montréal), Rim Cherif (HEC Montréal), Marie-Pier Côté (McGill), Nicolas Essis-Breton (Concordia), and Vincent Genest (Montréal)

**INTERDISCIPLINARY AND INDUSTRIAL
PROGRAMME**

Within the framework of the Institutes Innovation Platform (a project of the three Canadian mathematics institutes funded by NSERC), the CRM has begun organizing networking events in order to create and foster collaborations between mathematicians and industry. Each networking event lasts for one day and has a specific theme. (Note that an industrial problem solving workshop, such as those that the CRM has been organizing since 2007, lasts for a whole week and includes several problems.) A networking event consists of presentations of industrial problems by companies and presentations of research work by mathematicians working in academia. The presentations are followed by informal interactions that may lead to collaborations and partnership grant applications. In 2014–2015 two networking events were organized by Stéphane Rouillon (CRM Partnerships Development Officer) and Odile Marcotte (CRM Deputy Director, Partnerships). For each event we list the organizations and researchers who gave presentations on their work.

**CRM NETWORKING EVENT
AERONAUTICS**

March 9, 2015, CRM

Organizations: CRIAQ, Optech, Bombardier, Opal-RT Technologies, Bell Helicopter, and LASSENA

Researchers: Adam Oberman (McGill) and André Fortin (Laval)

Number of participants: 30

**CRM NETWORKING EVENT
3D PRINT**

April 27, 2015, CRM

Organizations: Réseau Québec-3D, Optech, Parallel Geometry, P4Bus, and Robic

Researchers: Charles Simoneau (ÉTS) and Antoine Tahan (ÉTS)

Number of participants: 33

ACTIVITIES ORGANIZED BY THE CRM LABORATORIES

The CRM activities described so far are organized to a large extent by mathematicians who belong to at least one laboratory of the CRM. The CRM members, however, also organize activities that are proposed and supported by the laboratories themselves.

GEOMETRIC ANALYSIS DAY

June 6, 2014, CRM

Sponsored by the Analysis Laboratory

Organizer: Alexandre Girouard (Laval)

R WORKSHOP

DEBUGGING AND PACKAGE WRITING

June 9, 2014, McGill University

Sponsored by the Statistical Laboratory and the Montréal Biostatistics Seminar Series

Organizers: Christian Genest (McGill), Erica E. M. Moodie (McGill), and Duncan J. Murdoch (Western Ontario)

R WORKSHOP

THE R WILL BE OVER BY CHRISTMAS: OPTIMIZATION TECHNIQUES

June 26, 2014, McGill University

Sponsored by the Statistics Laboratory and the Epidemiology, Biostatistics, and Occupational Health Student Society

Organizer: Erica E. M. Moodie (McGill)

MINI-WORKSHOP

APPLICATIONS OF ADS/CFT FOR COSMOLOGY AND BLACK HOLE PHYSICS

August 6–8, 2014, McGill University

Sponsored by the Mathematical Physics Laboratory, the High Energy Theory Group of McGill, and the Department of Physics of McGill University

Organizers: Robert Brandenberger, Yi-Fu Cai, and Ian Morrison (McGill)

LA STATISTIQUE AU SERVICE DE LA COLLECTIVITÉ HOMMAGE À LOUIS-PAUL RIVEST POUR SES 60 ANS

August 29, 2014, Université Laval

Sponsored by the Université Laval, the Statistics Laboratory, and the Association des statisticiennes et statisticiens du Québec

Organizers: Thierry Duchesne (Laval) and Christian Genest (McGill)

NUMERICAL OPTIMAL TRANSPORTATION

October 20–24, 2014, McGill University

Sponsored by the Analysis Laboratory and Mokaplan

Organizers: Jean-David Benamou (INRIA-Rocquencourt) and Adam M. Oberman (McGill)

CRM NIRENBERG LECTURES

IN GEOMETRIC ANALYSIS

MIN-MAX THEORY AND GEOMETRY

André Neves (Imperial College London)

March 20–24, 2015, CRM

In 2014–2015, for the second time, the Analysis Laboratory organized the Nirenberg Lectures in Geometric Analysis, named after Louis Nirenberg (a renowned mathematician who spent part of his life in Montréal). The lectures were devoted to Neves' recent breakthroughs (in collaboration with Fernando Codá Marques), which led to the solution of problems that had been open for a long time, particularly Willmore's conjecture. These lectures attracted a broad public, including many students and postdoctoral fellows. The CRM was honoured to host Professor Nirenberg himself, who attended the lectures. The reader will find a detailed description of Neves' lectures in the Fall 2015 edition of the Bulletin du CRM.

8TH MONTREAL SCIENTIFIC COMPUTING DAYS

May 11–12, 2015, CRM

Organizers: Adam M. Oberman (McGill), Emmanuel Lorin (Carleton), and Gantumur Tsogtgerel (McGill)

REPRODUCIBLE RESEARCH:

AN INTRODUCTION TO KNITR

May 28, 2015, McGill University

Sponsored by the Statistical Laboratory and the Montréal Biostatistics Seminar Series

Organizer: Erica E. M. Moodie (McGill)

“Grandes Conférences du CRM” and Colloquium

In 2006 the CRM launched the “Grandes Conférences” lecture series, in order to fulfil the expectations of a public wishing to understand important developments in the mathematical sciences. The “Grandes Conférences” feature outstanding lecturers able to convey the power and beauty of mathematical research to a wide audience. In 2014–2015 four lectures were delivered at the Université de Montréal: “Euler et les jets d’eau de Sans-Souci” by Yann Brenier (October 22, 2014); “Measuring Emotional States in Real-Time” by Chris Danforth (November 20, 2014); “The Antikythera Mechanism: An Astronomical Calculating Machine from Ancient Greece” by James C. Evans (March 18, 2015); and “Mille ans d’optique, 50 ans de solitons” by James Dudley (May 8, 2015). The reader will find below summaries of these four lectures, adapted from articles published by Christiane Rousseau in the Bulletin du CRM. Each of the lectures was attended by hundreds of persons of various backgrounds. The refreshments following the lectures allowed them to ask questions, renew old acquaintances, and meet other persons interested in science. The “Grandes Conférences du CRM” are under the stewardship of Christiane Rousseau and Yvan Saint-Aubin, both full professors at the Department of Mathematics and Statistics of the Université de Montréal.



YANN BRENIER

EULER ET LES JETS D’EAU DE SANS-SOUCI

**Yann Brenier
(Centre de Mathématiques Laurent Schwartz)**

In 1748 Frederick II of Prussia asked Leonhard Euler to design the water jets of its Sans-Souci palace. Much later Frederick II wrote to Voltaire: “I wished to make a water jet in my garden; Euler computed the effort of the wheels required to raise the water level in a basin... My mill was carried out geometrically and it was not able to raise a single drop of water at a distance of fifty steps from the basin. Vanity of vanities! Vanity of geometry!” Euler, however, left us equations describing the motion of the atmosphere and that of the oceans. Was the princely verdict fair? This topic was addressed by Yann Brenier in his lecture.

Yann Brenier is a CNRS “directeur de recherches” at the École Polytechnique in Paris. His research interests include in particular optimal transportation, convection, and fluid mechanics and its relationship to geometry. He was a junior member of the Institut Universitaire de France and was invited to present his work at the International Congress of Mathematicians held in Beijing in 2002 and the International Congress of Industrial and Applied Mathematics held in Sydney in 2003. He also delivered several series of prestigious lectures at the University of Chicago, the University of Maryland, the University of Bonn, and the ETH in Zürich. Yann Brenier was awarded the Petit d’Ormy Prize by the Académie des Sciences de Paris in 2005.





CHRIS DANFORTH

MEASURING EMOTIONAL STATES IN REAL-TIME

Chris Danforth (University of Vermont)

Our happiness depends upon our current location, the persons surrounding us, and our current activities. By analyzing a diverse and large set of texts reflecting the culture (including songs lyrics from the last 50 years, thousands of literary works, and 50 billion of Twitter state updates), Danforth and his collaborators were able to build a scientific instrument to quantify happiness in a given population. Among many fascinating observations on human behaviour, they discovered that signs of happiness were decreasing during the day and required a “reboot” during the night; that happiness increased or decreased as a function of age and a function of distance from the equator; and the atoms of language have a surprisingly prosocial bias. In his lively presentation Danforth described these results within the context of the “Computational Story Lab,” which aims to understand the geographical and topological dynamics of large-scale socio-technical phenomena. The reader will find more information on the site <http://hedonometer.org>.

Chris Danforth is Flint Professor of mathematical, natural, and technical sciences at the University of Vermont. He is the co-director of the Computational Story Lab, a group of applied mathematicians (including graduate and undergraduate students and postdoctoral fellows) working on large-scale systems problems in such areas as sociology, nonlinear dynamics, networks, ecology, and physics. Many media, including the New York Times, Science Magazine, and the BBC, have reported on Professor Danforth’s research. The reader will find descriptions of Danforth’s projects on his site (<http://uvm.edu/~cdanfort>) and his blog (<http://onehappybird.com>). A report on Danforth’s lecture may be found in the Spring 2015 edition of the Bulletin du CRM.



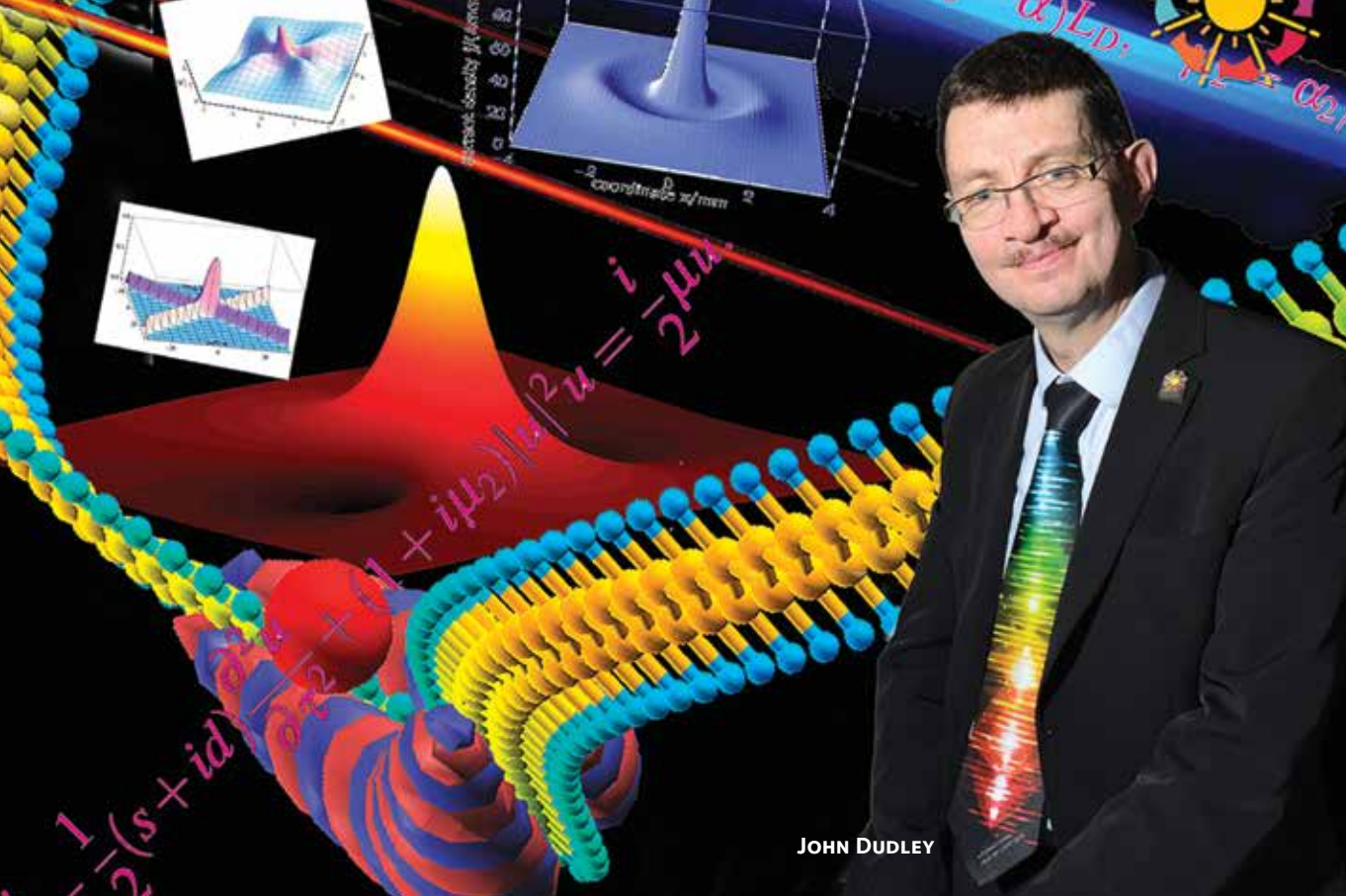
JAMES C. EVANS

THE ANTIKYTHERA MECHANISM: AN ASTRONOMICAL CALCULATING MACHINE FROM ANCIENT GREECE

James C. Evans (University of Puget Sound)

The Antikythera mechanism, a gearwork astronomical computing machine, was built by an ancient Greek mechanic around the second century BC, lost in a shipwreck around 60 BC, and recovered in 1901. Recent study has greatly improved our understanding of the mechanism. In this talk Professor Evans described the current state of understanding of the Antikythera mechanism and addressed the questions of its function and its cultural significance — why would anyone have built such a thing? The talk will also present some new evidence for the date of construction.

James Evans is a physicist and historian of science at the University of Puget Sound. His research interests include the history of physics since the 18th century and the astronomy of the ancient Greeks. He is the author of “The History and Practice of Ancient Astronomy” and the editor of the *Journal for the History of Astronomy*. His work on the mechanism of Antikythera, carried out with C. Carman, has recently been covered by the New York Times.



JOHN DUDLEY

MILLE ANS D'OPTIQUE, 50 ANS DE SOLITONS

**John Dudley
(Université de Franche-Comté
and Institut Universitaire de France)**

The United Nations proclaimed 2015 the International Year of Light and Light-based Technologies, in order to raise public awareness of the importance of light and related fields (optics, for instance) in everyday life. Because of the research on light in the last thousand years, it now occupies a crucial place in our society. Light has revolutionized medicine, given a large impetus to international communications, and plays a central role in many cultural, political, and economical features of our world. Several technological breakthroughs based on light are essential for sustainable development. The last fifty years have seen the rise of the nonlinear science of light, a research area at the intersection of optics, mathematics, and engineering. The second part of Professor Dudley's lecture gave an insight into this area, with a particular focus on the science of optical solitons, which are localized light states with diverse applications: for instance the optimization of optical telecommunication systems, the development of new sources for lasers, and the building of toy models to test the theories on the generation of rogue ocean waves. The reader will find a summary of Professor Dudley's lecture in the Fall 2015 edition of the Bulletin du CRM.

John Dudley was born in New Zealand and obtained his Ph.D. from the University of Auckland in 1992. He then was a postdoctoral fellow at the University of St. Andrews in Scotland. In 1994 he became a professor at the University of Auckland and in 2000 a professor at the Université de Franche-Comté (Besançon, France), where he is the director of the research group on optoelectronics and photonics. His research interests are in nonlinear optics and ultrafast optical phenomena. He has been a member of the Institut Universitaire de France since 2005 and has authored more than 150 articles. Among the distinctions he has received, let us mention that he was elected Fellow of the Optical Society of America in 2007, Fellow of the IEEE in 2011, and Fellow of the European Optical Society in 2012. In 2009 he was awarded the « Grand Prix de l'Electronique Général Ferrié » by the SEE. He was also awarded a silver medal by the CNRS in 2013 and has been president of the European Physical Society since 2013. He is the instigator and coordinator of the International Year of Light, launched with great fanfare on January 19 and 20, 2015.

COLLOQUE DES SCIENCES MATHÉMATIQUES DU QUÉBEC

The CRM, in collaboration with the Institut des sciences mathématiques (ISM), which coordinates graduate courses in mathematics in Québec, organizes a series of seminars. This colloquium includes survey talks by world-renowned mathematicians and statisticians and addresses topics at the leading edge of mathematical research.

In 2014–2015 the colloquium coordinators were Henri Darmon and Christian Genest (McGill University) and Iosif Polterovich and Yvan Saint-Aubin (Université de Montréal).

October 2, 2014, Montréal

Paul Bourgade (New York University)
Universality in random matrix theory

October 9, 2014, Montréal

Alex Kontorovich (Rutgers University)
Applications of additive combinatorics to homogeneous dynamics

October 30, 2014, Montréal

Georgia Benkart (University of Wisconsin–Madison)
A pedestrian approach to group representations

November 6, 2014, Montréal

Dani Wise (McGill University)
The cubical route to understanding groups

November 13, 2014, Montréal

Kartik Prasanna (University of Michigan)
Recent advances in the arithmetic of elliptic curves

November 20, 2014, Montréal

Martin Wainwright (University of California, Berkeley)
High-dimensional phenomena in mathematical statistics and convex analysis

November 27, 2014, Laval

Nilima Nigam (Simon Fraser University)
On the well-posedness of the 2D stochastic Allen–Cahn equation

December 4, 2014, Montréal

François Bergeron (UQAM)
Algebraic combinatorics and finite reflection groups

January 22, 2015, McGill

Hansjoerg Albrecher (Université de Lausanne)
On the usefulness of mathematics for insurance risk theory – and vice versa

January 29, 2015, McGill

Thomas Ransford (Université Laval)
Spectres et pseudospectres

February 5, 2015, McGill

Octav Cornea (Université de Montréal)
Cobordism and Lagrangian topology

February 12, 2015, McGill

Laure Saint-Raymond (École normale supérieure)
Influence des côtes sur les courants marins

February 19, 2015, Montréal

Francis Brown (IHÉS)
Irrationality proofs, moduli spaces and dinner parties

February 26, 2015, McGill

Alistair Savage (University of Ottawa)
Categorification in representation theory

March 5, 2015, McGill

Sophie Morel (Princeton University)
Periods

March 12, 2015, Montréal

Pierre Colmez (Institut Mathématique de Jussieu)
The upper half-planes

March 19, 2015, McGill

Alexei Borodin (MIT)
Integrable probability

March 26, 2015, McGill

Steven Boyer (UQAM)
Left-orderings of groups and the topology of 3-manifolds

April 2, 2015, McGill

William Minicozzi (MIT)
Uniqueness of blowups and Lojasiewicz inequalities

April 2, 2015, Sherbrooke

Konstantin Mischaikow (Rutgers University)
A combinatorial approach to dynamics applied to switching networks

April 9, 2015, Montréal

Stephen S. Kudla (University of Toronto)
Modular generating series and arithmetic geometry

May 1st, 2015, Laval

Éric Moulines (Télécom ParisTech)
Gradient proximal stochastique et applications pour l'inférence de modèles à effets mixtes en grande dimension

May 7, 2015, Sherbrooke

Robert Lund (Clemson University)
A statistical view of some recent climate controversies

THE CRM LABORATORIES

One of the most important characteristics of the CRM (and one shared by only a few world-class institutes) is its dual nature: the CRM is at the same time a collaborative and thematic resource and a cluster of twelve research laboratories. Thus one finds in the CRM a combination of two models: the classical model (i.e., an institute with a stable membership) and the thematic model (i.e., an institute that organizes thematic programmes and gathers researchers from all over the world around these programmes).

The CRM laboratories are focal points for the local scientific activity and take an active part in the scientific programmes of the CRM. The members of laboratories organize thematic years or semesters and activities and seminars sponsored by the laboratories themselves; they train graduate students and postdoctoral fellows. Each laboratory includes members from several universities and promotes the collaboration between researchers from diverse institutions.

MATHEMATICAL ANALYSIS

At the same time classical and central to modern mathematics, analysis involves the study of continuous systems, from dynamical systems to solutions of partial differential equations and spectra of operators. In 2014–2015 the Laboratory included 31 regular and 10 associate members working at 13 different universities in Canada, the United Kingdom, France, and Austria. The members of the Laboratory work in the following areas: harmonic analysis, complex analysis, several complex variables, potential theory, functional analysis, Banach algebras, microlocal analysis, analysis on manifolds, nonsmooth analysis, spectral theory, partial differential equations, geometric analysis, ergodic theory and dynamical systems, control theory, mathematical physics, applied mathematics, probability, nonlinear analysis, nonlinear differential equations, topological methods in differential equations, fluid dynamics, and turbulence.

HIGHLIGHTS

Jérôme Vétois, professor at McGill University, became a member of the Analysis Laboratory in 2014–2015. Laboratory members organized several activities mentioned elsewhere in this report: the Nirenberg Lectures in Geometric Analysis, the Geometric Analysis Day, and the Short Thematic Programme on Current Topics in Mathematical Physics. Among the researchers invited by members of the Analysis Laboratory in 2014–2015 let us mention Frédéric Naud (Université d'Avignon), David Ruelle (IHÉS), Nicolae Vulpe (Academy of Sciences of Moldova), Joan Carles Artés (Universitat Autònoma de Barcelona), and Robert Roussarie (Université de Dijon).

Thomas Ransford gave a plenary lecture at the Summer Meeting of the Canadian Mathematical Society (in June 2014). In June 2014 also, Javad Mashreghi and Thomas Ransford organized a research group at the Banff International Research Station on Dirichlet spaces and Granges–Rovnyak spaces. Karim Kellay (from Bordeaux) and Omar El-Fallah (from Rabat) were the other members of this group and its work resulted in the publication of two articles: one article in collaboration with Emmanuel Fricain in Constructive Approximation and one article in collaboration with Hubert Klaja in Complex Analysis and Operator Theory. Frédéric Gourdeau was awarded the Adrien-Pouliot Prize during the Winter Meeting of the Canadian Mathematical Society in December 2014.

The students supervised by the members of the Analysis Laboratory continue to receive prestigious fellowships and accept prestigious positions. In particular Yaiza Canzani and Malik Younsi (who received the Governor General's Gold Medal for his Ph.D. thesis) were awarded postdoctoral fellowships by NSERC. Guillaume Roy-Fortin is Ralph Boas Assistant Professor at Northwestern University and Martin Klimes is a postdoctoral fellow at the Université de Strasbourg. In January 2015 Dominique Guillot obtained a tenure-track position at the University of Delaware.

SEMINARS

The members of the Analysis Laboratory organize several seminars: the Nonlinear Analysis Seminar, the Joint McGill-Concordia Analysis Seminar, the Analysis Seminar at Université Laval, the Montreal Analysis Seminar, and the Spectral Theory Seminar.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the members of the Analysis Laboratory supervised or cosupervised one undergraduate student, 41 M.Sc. Students, 31 Ph.D. Students, and 14 postdoctoral fellows.

DIRECTOR

Dmitry Jakobson (McGill)

REGULAR MEMBERS

Marlène Frigon, Paul M. Gauthier, Iosif Polterovich, Christiane Rousseau, Dana Schlomiuk (Montréal)

Stephen W. Drury, Vojkan Jakšić, Ivo Klemes, Paul Koosis, John A. Toth, Jérôme Vétois (McGill)

Abraham Boyarsky, Galia Dafni, Pawel Góra, Alexey Kokotov, Alexander Shnirelman, Alina Stancu, Ron J. Stern (Concordia)

Line Baribeau, Alexandre Girouard, Frédéric Gourdeau, Javad Mashreghi, Thomas J. Ransford, Jérémie Rostand (Laval)

Tomasz Kaczinski (Sherbrooke)

Dominic Rochon (UQTR)

Vadim Kaimanovich (Ottawa)

Donald A. Dawson (Carleton)

Richard Fournier (Dawson College)

Francis H. Clarke (Lyon 1)

Robert Seiringer (IST Austria)

ASSOCIATE MEMBERS

Octav Cornea, Richard Duncan, Samuel Zaidman (Montréal)
Kohur Gowrisankaran, Pengfei Guan, Niky Kamran (McGill)
John Harnad, Dmitry Korotkin (Concordia)
Nilima Nigam (Simon Fraser)
Yiannis Petridis (University College, London)

CAMBAM CENTRE FOR APPLIED MATHEMATICS IN BIOSCIENCE AND MEDICINE

The mission of the Centre for Applied Mathematics in Bioscience and Medicine (CAMBAM) is to be a leading institution in the application of mathematics to address challenges in bioscience and medicine through partnerships with industry, government, and other stakeholders in society. CAMBAM meets its objectives by promoting and fostering research, teaching, and training in applications of quantitative biology at all levels ranging from the molecular/genetic through single-cell and whole-organ physiology and biology to population dynamics and broader ecological questions, on time scales from the present to the evolutionary; by honing the talents of students at all levels through unique training opportunities in academic and non-academic settings; and by conducting applied research of the highest scientific rigour, meeting existing industry and societal demands in clinical and public health settings.

HIGHLIGHTS

In July 2014 CAMBAM took part in the organization of an international summer school called *Joint 2014 MBI-CAMBAM-NIMBioS Summer Graduate Program on Rhythms & Oscillations*, and whose organizers were Daniel Forger (University of Michigan) and Paul François (CAMBAM member and professor of physics at McGill University). This summer school was followed by a school held at McGill in June 2015. The two schools were the result of a collaboration between CAMBAM, the Mathematical Biosciences Institute (Ohio State University), and the National Institute for Mathematical and Biological Synthesis (University of Tennessee). CAMBAM held its annual meeting on April 28, 2015, at the Université de Montréal; this meeting gathered 48 participants and consisted of presentations and scientific posters prepared by the student members of CAMBAM.



FRÉDÉRIC GUICHARD

SEMINARS

CAMBAM organized two seminar series in 2014–2015. The first series, called Cutting Edge Lecture Series, is geared towards the general public and consists of one lecture per month, delivered at the Redpath Museum of McGill University. Each lecture draws more than 80 persons. The second series is attended by CAMBAM members: it consists of lectures delivered by CAMBAM researchers and invited researchers, who present their work. There were 31 lectures of this kind in 2014–2015.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the members of CAMBAM supervised or cosupervised 21 M.Sc. students, 25 Ph.D. students, and 6 postdoctoral fellows.

CODIRECTORS

Erik Cook and Frédéric Guichard (McGill)

REGULAR MEMBERS

Jacques Bélair, Alain Vinet (Montréal)
Pedro Peres-Neto (UQAM)

Mathieu Blanchette, David L. Buckeridge, Maurice Chagnon, Vamsy Chodavarapu, Kathleen Cullen, Paul François, Gregor Fussman, Leon Glass, Michael Guevara, Anthony R. Humphries, Anmar Khadra, Svetlana V. Komarova, Brian Leung, Michael C. Mackey, Jacek Majewski, Sam Musallam, Christopher Pack (McGill)
André Longtin (Ottawa)

ASSOCIATE MEMBERS

Fahima Nekka (Montréal)
Juli Atherton (UQAM)
Lea Popovic (Concordia)
Claire de Mazancourt, Michel Loreau
(Station d'Écologie Expérimentale du CNRS à Moulis)
Moisés Santillán Zerón (Cinvestav)
Vincent Lemaire (Pfizer)

CICMA CENTRE INTERUNIVERSITAIRE EN CALCUL MATHÉMATIQUE ALGÈBRIQUE

CICMA includes researchers working in number theory, group theory, and algebraic geometry. Algebraic geometry is a broad discipline having close links with diverse fields from arithmetic to theoretical physics. Eyal Goren and Adrian Iovita are leaders in the application of techniques from algebraic geometry to problems arising in number theory, especially Shimura varieties and p -adic cohomology theories. John McKay is one of the instigators of the moonshine programme, which ties together in a surprising way certain notions in the theory of modular forms, arithmetic geometry, and theoretical physics.

Number theory has developed over the last decades following two major trends: on one hand algebraic number theory, including such themes as the study of special values of L -functions attached to arithmetic objects, which originates in the work of Gauss and Dirichlet and leads to the modern conjectures of Deligne, Beilinson, and Bloch-Kato. Another theme of algebraic number theory, originating in the Langlands programme, postulates a close link between arithmetic L -functions and automorphic representations.

On the other hand analytic number theory addresses deep and subtle questions concerning the distribution of primes. It makes use of mathematical analysis techniques, especially functions of several complex variables and spectral theory. Number theory in all its different flavours is particularly well represented in the laboratory, with Darmon, Goren, Iovita, and Kassaei on the arithmetic and automorphic side, and David, Granville, Kisilevsky, Koukoulopoulos, and Lalin on the more analytic side of the subject.

HIGHLIGHTS

The thematic year in number theory, described at the beginning of the present report, was the main focus of CICMA in 2014–2015. This year was also a bright one as far as research is concerned, since three of the ten breakthroughs in number theory over the last four years were made by CICMA members and former postdocs in 2014–2015: the work of Matomäki-Radziwill on multiplicative functions in short intervals; the work of Andreatta, Iovita, and Pilloni on p -adic families of Siegel modular forms; and the work of Andreatta, Goren, Howard, and Madapusi Pera on the conjecture of Bruinier-Kudla-Yang (with applications to the solution of the André-Oort conjecture). The first two of these breakthroughs have already been accepted for publication in the *Annals of Mathematics*.

SEMINARS

The members of CICMA organize the Analytic Number Theory Seminar and the Québec-Vermont Number Theory Seminar.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the members of CICMA supervised or cosupervised 2 undergraduate students, 20 M.Sc. students, 46 Ph.D. students, and 20 postdoctoral fellows.

DIRECTOR

Henri Darmon (McGill)

REGULAR MEMBERS

Andrew Granville, Dimitris Koukoulopoulos, Matilde Lalin (Montréal)

Eyal Z. Goren, Payman L. Kassaei, John Labute, Michael Makkai, Peter Russell (McGill)

Chris J. Cummins, Chantal David, David Ford, Adrian Iovita, Hershky Kisilevsky, John McKay, Francisco Thaine (Concordia)

Hugo Chapdelaine, Jean-Marie De Koninck, Antonio Lei, Claude Levesque (Laval)

Damien Roy (Ottawa)

M. Ram Murty (Queen's)

David S. Dummit (Vermont)

Maksym Radziwill (Rutgers)

CIRGET CENTRE INTERUNIVERSITAIRE DE RECHERCHES EN GÉOMÉTRIE ET TOPOLOGIE

Topology and differential geometry are fundamental disciplines of mathematics whose richness and vitality, evident throughout history, reflect a deep link to our experience of the universe. They are a focal point of modern mathematics and indeed 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.

CIRGET, based at UQAM, is composed of 20 regular members, 5 associate members, and a large number of postdoctoral fellows and graduate students working in this broad field. The main themes to be pursued in the coming years include the topological classification of 3-dimensional manifolds; the quantization of Hitchin systems and the geometric Langlands program; the classification of special Kähler metrics; the study of symplectic invariants, especially in dimension 4; nonlinear partial differential equations in Riemannian geometry, convex geometry, and general relativity; and Hamiltonian dynamical systems. Two further domains are represented within CIRGET: algebraic geometry (through Steven Lu's and Peter Russell's work) and geometric group theory (through Daniel Wise's work).

HIGHLIGHTS

CIRGET acquired three new members this year: Mikaël Pichot (McGill), Mark Powell (UQAM), and Piotr Przytycki (McGill). Pichot and Przytycki work in the area of geometric group theory and Mark Powell in low-dimensional topology. Clément Hyvrier, who works in symplectic geometry and is a professor at the Cégep of Saint-Laurent, is a new associate member of CIRGET.

CIRGET is very proud of Professor Dani Wise, to whom several prestigious prizes were awarded this year (on account of the originality and deep impact of his work). In particular he was awarded the Veblen Prize of the American Mathematical Society (jointly with Ian Agol from Berkeley). Also he was an invited speaker at the International Congress of Mathematicians in Seoul, was elected a member of the Royal Society of Canada, and received the 2015 CRM-Fields-PIMS Prize.

Octav Cornea (from the Université de Montréal) was named Simons Fellow in mathematics by the Simons Foundation. The 40 Mathematics Fellows chosen in 2015 (including four professors in Canadian universities and 36 professors from American universities) are all top-notch mathematicians at various stages of their respective careers.

Finally Xiangwen Zhang (a former CIRGET postdoctoral fellow) was awarded the Doctoral Prize of the Canadian Mathematical Society for his thesis, entitled *Complex Monge-Ampère Equation and its Applications to Complex Geometry*. His work, carried out at McGill University, was supervised by Professor Pengfei Guan. Zhang is now Ritt Assistant Professor at Columbia University.

SEMINARS

CIRGET members organize the Geometry and Topology Seminar, the Geometric Group Theory Seminar, the Symplectic Topology Seminar, and the CIRGET Junior Seminar.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014-2015 the CIRGET members supervised or cosupervised two undergraduate students, 34 M.Sc. students, 37 Ph.D. students, and 20 postdoctoral fellows.

DIRECTOR

Steven Boyer (UQAM)

REGULAR MEMBERS

Abraham Broer, Octav Cornea, François Lalonde, Iosif Polterovich (Montréal)

Vestislav Apostolov, Olivier Collin, André Joyal, Steven Lu, Mark Powell, Frédéric Rochon (UQAM)

Pengfei Guan, Jacques Hurtubise, Niky Kamran, Mikaël Pichot, Piotr Przytycki, Peter Russell, Johannes Walcher, Daniel T. Wise (McGill)

Virginie Charette (Sherbrooke)

ASSOCIATE MEMBERS

Dmitry Jakobson, John A. Toth (McGill)

Syed Twareque Ali, John Harnad (Concordia)

Clément Hyvrier (Cégep de Saint-Laurent)



ANDRÉ FORTIN

GIREF GROUPE INTERDISCIPLINAIRE DE RECHERCHE EN ÉLÉMENTS FINIS

The recent advances in computer hardware and software allow researchers to model and simulate physical phenomena whose complexity is unheard of. These problems are characterized by nonlinear laws, non-differentiable friction laws, large-deformation geometries, complex solid-solid or fluid-solid interactions, problems in multiphysics, etc. Such problems can be found everywhere in industrial environments, especially in the design and fabrication of high-technology products. Hence the members of GIREF (an acronym that means "Interdisciplinary Research Group in Finite Element Methods") aim to develop original numerical methods for solving cutting-edge industrial problems in nonlinear mechanics. Their work concern pure mathematics, computer science, software engineering, and engineering. The GIREF members propose general methods that can be used for diverse industrial applications. The 29 members of GIREF reflect the interdisciplinary nature of the laboratory and are based at the Université Laval and the École Polytechnique de Montréal, as well as the Universities of Moncton, Ottawa, and Alberta.

HIGHLIGHTS

This year GIREF welcomed a new professor, Jean Deteix, as a regular member. Deteix is now a professor at the Université Laval and has joined the NSERC Research Chair in High Performance Scientific Computing with José Urquiza and André Fortin. Among the new grants obtained by GIREF let us mention a FRQNT team grant awarded to a team including André Fortin, Nicolas Doyon, Paul De Koninck, and Simon Hardy (all from the Université Laval). André Garon (Polytechnique Montréal) received an Innovation Grant from NSERC for a project entitled "Minimally invasive multi-drain thoracic catheter." A patent was also obtained in the course of this work. GIREF members continued to work in diverse fields: Lagrangian coherent structures, fluid-structure interactions, biological and medical modelling, fluid and solid mechanics, frictional contact problems, large deformation problems, iterative methods for large-scale systems, etc.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the GIREF members supervised or cosupervised one undergraduate student, 11 M.Sc. students, 12 Ph.D. students, and 4 postdoctoral fellows.

DIRECTOR

André Fortin (Laval)

DEPUTY DIRECTOR

André Garon (Polytechnique Montréal)

REGULAR MEMBERS

Marie-Laure Dano, Jean Deteix, Nicolas Doyon, Michel Fortin, Robert Guénette, Jean-Philippe Lessard, Hassan Manouzi, Jean-Loup Robert, René Therrien, José Manuel Urquiza (Laval)

ASSOCIATE MEMBERS

Michel Delfour (Montréal)

Alain Cloutier, Claire Deschênes, Guy Dumas, Khader Khadraoui, Mathieu Olivier, Seyed Mohammad Taghavi (Laval)

Stéphane Étienne, François Guibault, Dominique Pelletier (Polytechnique Montréal)

Marie-Isabelle Farinas (UQAC)

Yves Secrétan (INRS-ETE)

Yves Bourgault (Ottawa)

Pietro-Luciano Buono (UOIT)

Mohamed Farhloul, Sophie Léger (Moncton)

Youssef Belhamadia (Alberta)

Jean-François Héту (CNRC-IMI)

LACIM

LABORATOIRE DE COMBINATOIRE ET D'INFORMATIQUE MATHÉMATIQUE

LaCIM (French acronym meaning “Combinatorics and Mathematical Informatics Laboratory”) is home to mathematics and theoretical computer science researchers whose interests comprise discrete mathematics and the mathematical aspects of computer science. Founded in 1989, LaCIM includes 16 regular members (of whom 9 are UQAM professors) and one associate member. It welcomes postdoctoral fellows and its regular members supervise or cosupervise many M.Sc. and Ph.D. students, as well as undergraduate and cégep summer research students. Many renowned mathematicians visit LaCIM and collaborate with its members in the following areas: enumerative and bijective combinatorics, theory of species, algebraic combinatorics, combinatorics of finite and infinite words, discrete geometry, theory of languages and automata, Gray codes, bioinformatics and genomics, and combinatorial optimization..



SREČKO BRLEK

HIGHLIGHTS

LaCIM is very proud that one of its members, Professor Srečko Brlek, received the Adrien-Pouliot Prize of Acfas. This prize, recognizing works of scientific cooperation with France, was awarded to Brlek because of thirty years of collaborative projects with France leading to the creation of LIRCO (a CNRS international laboratory) and the UMI-CRM (whose application was prepared jointly with Odile Marcotte of the CRM). The CNRS has renewed for four years (2015–2019) the mandate of LIRCO, which gathers around one hundred researchers in France and Québec.

The French “core” of LIRCO is LaBRI (a laboratory in Bordeaux) and its Québec “core” is LaCIM. LaCIM received many international visitors for long or short visits during 2014–2015. In 2015 the Canada Research Chair in Algebra, Combinatorics, and Mathematical Computer Science (UQAM) was awarded to Hugh R. Thomas and the Canada Research Chair in Biological and Computational Complexity (Université de Sherbrooke) to Aïda Ouangraoua, a former LaCIM postdoctoral fellow.

SEMINAR

Each week the Combinatorics and Theoretical Computer Science Seminar gathers the LaCIM members, students, and postdoctoral fellows for a lecture given by a visitor or a Montréal researcher.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the LaCIM members supervised or cosupervised 31 M.Sc. students, 23 Ph.D. students, and 11 postdoctoral fellows.

DIRECTOR

Srečko Brlek (UQAM)

REGULAR MEMBERS

Sylvie Hamel (Montréal)

Anne Bergeron, François Bergeron, Alexandre Blondin Massé, Christophe Hohlweg, Gilbert Labelle, Vladimir Makarencov, Christophe Reutenauer, Franco Saliola (UQAM)

Ibrahim Assem, Thomas Brüstle, Shiping Liu (Sherbrooke)

Benoît Larose (Champlain Regional College)

Cédric Chauve, Marni Mishna (Simon Fraser)

ASSOCIATE MEMBER

Timothy Walsh (UQAM)

APPLIED MATHEMATICS

The Applied Mathematics Laboratory is a research network of 19 applied mathematicians, engineers, computer scientists, and chemists, based in Montréal. The laboratory exists primarily to stimulate research and collaboration in the applied mathematical research areas of its members by fostering discussion and the creation of ideas through conferences, workshops, and seminars, and the furtherance of research through its visitors' programme and the appointment of talented postdoctoral fellows. The laboratory is also very concerned with the training of young researchers and supports travel and conference attendance of its postdoctoral fellows.

The research interests of the laboratory members are quite diverse although there are a number of common threads that make interchange and collaboration both possible and fruitful. Active areas of research represented within the laboratory include, for example, the application of dynamical systems theory to complex phenomena, high-dimensional chaos, and biology. There is also an interest in numerical linear algebra and its applications, including the design, analysis, and implementation of effective computer algorithms. Amongst the membership one will also find expertise in numerical simulation, applied dynamical systems, quantum chemistry, turbulence, combustion, biomechanics, numerical methods in fluid mechanics and electromagnetism, hp-finite element methods, molecular dynamics, control, optimization, preconditioners, and large-scale eigenvalue problems.

HIGHLIGHTS

The highlight activity of 2014–2015 was the 8th Montreal Scientific Computing Days, which took place on May 11 and 12, 2015, and were organized by Adam M. Oberman, Emmanuel Lorin de la Grandmaison, and Gantumur Tsogtgerel (as mentioned earlier in this report). The goal of the meeting was to bring together members of the regional scientific computing community. This meeting allowed local researchers to learn about the work of their colleagues through talks by senior members and presentations by junior faculty, postdoctoral researchers, and students. In addition outside experts were brought in to increase the profile of the meeting.

A three-hour mini-course on Mean Field Games was given by Peter Caines (McGill University, Department of Electrical Engineering) and Arman Kizikale (GERAD). Two hours were devoted to theory and one hour to the presentation of a project using Mean Field Games for power consumption. This project, joint with Hydro-Québec, aims to control space heaters and water heaters to respond to instantaneous changes in the power supply. For example, if a wind generator breaks down, there is a jump in the power supply. Previous methods adjusted the supply by burning coal, which is costly and environmentally destructive. The proposed method would make minor changes in the power consumption at the level of the consumer, leading to large energy savings.

The external speakers were Guillaume Carlier (Paris Dauphine and INRIA), who spoke on the Augmented Lagrangian Method for Mean Field Games, and Julien Rabin (Université de Caen), who spoke on Adaptive Colour Transfer with Relaxed Optimal Transport.

SEMINAR

The laboratory members organize the CRM/McGill Applied Mathematics Seminar.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the members of the Applied Mathematics Laboratory supervised or cosupervised 21 M.Sc. students, 36 Ph.D. students, and 13 postdoctoral fellows.

DIRECTOR

Adam Oberman (McGill)

REGULAR MEMBERS

Jacques Bélair, Anne Bourlioux, Robert G. Owens (Montréal) Peter Bartello, Peter Edwin Caines, Xiao-Wen Chang, Rustum Choksi, Anthony R. Humphries, Jean-Christophe Nave, Bruce Shepherd, Gantumur Tsogtgerel, Adrian Vetta, Jian-Jun Xu (McGill)

Eusebius J. Doedel (Concordia)

André D. Bandrauk (Sherbrooke)

Emmanuel Lorin (Carleton)

ASSOCIATE MEMBERS

Sherwin A. Maslowe (McGill)

Jean-Philippe Lessard (Laval)

MATHEMATICAL PHYSICS

The mathematical physics group is one of the oldest and most active at the CRM. It consists of 19 regular members, 10 local associate members (all full-time faculty members at one of the participating universities), and 8 external associate members working permanently at universities and research laboratories in Europe, the U.S., or Mexico. The group carries out research in many of the most active areas of mathematical physics: coherent nonlinear systems in fluids, optics, and plasmas; classical and quantum integrable systems; the 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; foundational questions in quantization; asymptotics of eigenstates; coherent states; wavelets; supersymmetry; the symmetry analysis of PDEs and difference equations; representation theory of Lie groups and quantum groups; and the mathematical structure of classical and quantum field theories.

HIGHLIGHTS

In 2014–2015 the members of the Mathematical Physics Laboratory continued to enjoy an international reputation. We will mention here only a few of their activities and the honours they received. In the calendar year 2015 Robert Brandenberger gave 34 invited talks at universities, workshops, and conferences across the world and published 11 papers in international journals. Marco Bertola was appointed External Lecturer at SISSA (Italy) from January to May 2015. He was an invited lecturer at the XXXIX Summer School on Mathematical Physics (Ravello, Italy, in September 2014) and the XXXIII Workshop on Geometric Methods in Physics (Białowieża, Poland, in June 2014). Michel Grundland had six publications in refereed journals concerning soliton surfaces and generalized symmetries. He was also an invited speaker at seven international conferences in Italy, Poland, and the Czech Republic. In 2014–2015 John Harnad published five articles in international journals, mainly on the theme of weighted Hurwitz numbers and their generating functions. He also gave eight invited addresses at international conferences and workshops. Between May 3 and July 11, 2015, he was an invited participant at the research programme “Statistical Mechanics, Integrability and Combinatorics” at the Galileo Galilei Institute for Theoretical Physics in Florence.

Alex Maloney was a visiting researcher at Harvard University from June to August 2014. His work entitled “String Universality for Symmetric Product Orbifolds” (written by A. Maloney, A. Belin, and C. Keller) was the subject of an article in the popular magazine *Quanta*. In 2014–2015 Jiří Patera published (or posted on arXiv) six articles on icosahedral symmetries and hybrid characters of simple Lie groups. Vasilisa Shramchenko gave an invited lecture at the Workshop on Quantum Curves, Hitchin systems, and the Eynard–Orantin Theory (AIM, Palo Alto, in September 2014) and another one at the Conference on Cluster Algebras in Mathematics and Physics (KIAS, Seoul, in December 2014). Luc Vinet gave nine invited talks at international conferences, including a plenary talk at the International Colloquium on Group Theoretical Methods in Physics (Ghent, in July 2014); the Keynote Talk at the Conference on Orthogonal Polynomials and q -Series (Orlando, in May 2015); and a plenary talk at the CRM-ICMAT workshop on Exceptional Orthogonal Polynomials and Exact Solutions in Mathematical Physics (Madrid, in September 2014). Luc Vinet published (or posted on arXiv) 13 articles during 2014–2015. One Ph.D. student and three M.Sc. students, all supervised by Luc Vinet, were awarded their degrees during the academic year in question.

SEMINARS

The laboratory members organize two seminars: the working seminar in mathematical physics, which takes place at Concordia or McGill on Thursday afternoon (and is sometimes held jointly with the Probability Seminar); and the Mathematical Physics Seminar, which takes place at the CRM on Tuesday afternoon.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014–2015 the members of the Mathematical Physics Laboratory supervised or cosupervised 8 undergraduate students, 21 M.Sc. students, 33 Ph.D. students, and 18 postdoctoral fellows.

DIRECTOR

John Harnad (Concordia)

REGULAR MEMBERS

Véronique Hussin, Manu B. Paranjape, Jiří Patera,
Yvan Saint-Aubin, Luc Vinet, Pavel Winternitz (Montréal)
Robert Brandenberger, Keshav Dasgupta, Jacques Hurtubise,
Alexander Maloney, Johannes Walcher (McGill)
Syed Twareque Ali, Marco Bertola, Richard L. Hall, Dmitry
Korotkin (Concordia)
Pierre Mathieu (Laval)
Vasilisa Shramchenko (Sherbrooke)
Alfred Michel Grundland (UQTR)

ASSOCIATE MEMBERS

Alexander J. Hariton, François Lalonde, Igor Loutsenko (Montréal)
Dmitry Jakobson, Vojkan Jakšić, Niky Kamran, John A. Toth (McGill)
Chris J. Cummins, Alexander Shnirelman (Concordia)
Stéphane Durand (Cégep Édouard-Montpetit)
Robert Conte, Bertrand Eynard (CEA-Saclay)
Jean-Pierre Gazeau (Paris Diderot)
Alexander R. Its (IUPUI)
Decio Levi (Roma Tre)
Robert Seiringer (IST Austria)
Alexander Turbiner (UNAM, Mexico)
Peter Zograf (Steklov Institute of Mathematics, St. Petersburg)

PHYSNUM

Applied mathematics now plays an important role in the biomedical field and especially the neurosciences. The research activity at PhysNum ("Numerical Physics") has two main themes: pharmacometrics and brain imaging. In particular Jean-Marc Lina and Habib Benali study the multi-modal imaging of the spinal cord, Lina and Christophe Grova the multiresolution and multimodal imaging in magneto-electrophysiology, and Benali and Maxime Descoteaux models of the anatomical and functional connectivity of the brain. Grova also studies neurovascular models in epilepsy and Lina studies sparse representations, inverse problems, brain wave synchronization, and scale-invariant processes in electrophysiology.

Fahima Nekka and her team conduct research in pharmacometrics, a discipline whose goal is to interpret and describe pharmacological phenomena in a quantitative manner, so as to support rational therapeutic decisions and improvement of patient health. They have developed a whole framework of probabilistic pharmacometrics in which different sources of variability and the nonlinearity of the system are accounted for. The team is working on compliance metrics and ranking and on direct and inverse problems related to patient drug behaviour and the therapeutic effect of drugs. It is conceiving tools that shed new light on drug development and evaluation, revisiting classical concepts in pharmacology and developing models for drug interactions.

HIGHLIGHTS

In 2014-2015 the members of PhysNum continued their research work in neuroimaging and pharmacometrics. Their research in neuroimaging involves the modelling of the neurovascular coupling (F. Lesage) and its study in a pathological environment, i.e., epilepsy (C. Grova), thanks to optical imaging in infrared spectroscopy. Another research area is structural brain imaging, mainly the imaging of white matter fibres through diffusion MRI (M. Descoteaux). Researchers working on this project are starting to collaborate with the electromagnetic brain imaging group (J.-M. Lina) in order to insert the structural imaging of fibres into the solution of the inverse problem in electroencephalography and magnetoencephalography. In 2014-2015 the laboratory continued to hold its weekly research seminars at the CRM on the topic of the Bayesian approach for imaging with the maximum entropy principle; a particular concern of these seminars was the integration of methodological advances into the Brainstorm software (presented at the Biomag 2014 conference). Finally the research work on the time/frequency analysis of signals focuses on the prediction of epileptic seizures through the multifractal model (J.-M. Lina) and on the dependence of the Hölder regularity of the intracranial signal upon the sleep stage (studied within the framework of a collaboration between J.-M. Lina and K. Jerbi).

In January 2015 Professor Fahima Nekka received an infrastructure grant of 117,235 dollars from the Canadian Foundation for Innovation, in order to build a software platform that will allow a better understanding of the therapeutic effect of medication. On the other hand the Faculty of Pharmacy of the Université de Montréal redefined its research axes: the new axis "Pharmacometrics and Pharmacotherapy" is under the direction of Fahima Nekka.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014-2015 the members of PhysNum supervised or cosupervised 20 M.Sc. students, 31 Ph.D. students, and 12 postdoctoral fellows.

DIRECTOR

Jean-Marc Lina (ÉTS)

REGULAR MEMBERS

Fahima Nekka (Montréal)
Christophe Grova (Concordia)
Frédéric Lesage (Polytechnique Montréal)
Maxime Descoteaux (Sherbrooke)
Alain Arnéodo (Laboratoire de physique, ENS de Lyon)
Habib Benali (LIF, UPMC)



LEA POPOVIC



JEAN-FRANÇOIS RENAUD

MONTRÉAL PROBABILITY GROUP

In 2014 the CRM ratified the creation of a new CRM laboratory in probability: the Montreal Probability Group. The research interests of the group span theoretical and applied, continuous and discrete probability. One important stream of research within the laboratory is the development and analysis of probabilistic models for physical, biological, statistical, and computational systems. The creation of this laboratory highlights the quality of probability research in the Montréal region and the recent influx of researchers in this area.

HIGHLIGHTS

Dima Jakobson became editor-in-chief of the *Annales mathématiques du Québec* in January 2015. Louis-Pierre Arguin was awarded the 2015 André-Aisenstadt Prize. Louigi Addario-Berry was appointed CRM Deputy Director, Scientific Programs in July 2015. A CRM-ISM postdoctoral fellowship (for two years) was awarded to Janosch Ortmann, who will work with the members of the laboratory. Recall that Louigi Addario-Berry, a member of the laboratory, was one of the organizers of the workshop on New Approaches in Probabilistic and Multiplicative Number Theory, one of the workshops of the 2014-2015 thematic year. Finally the members of the Montréal Probability Group prepared the 2015 CRM-PIMS Summer School in Probability.

SEMINARS

The laboratory members organize the CRM-ISM Probability Seminar.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014-2015 the members of the Montréal Probability Group supervised or cosupervised 8 M.Sc. students, 16 Ph.D. students, and 5 postdoctoral fellows.

DIRECTOR

Lea Popovic (Concordia)

REGULAR MEMBERS

Louis-Pierre Arguin, Alexander Fribergh, Sabin Lessard (Montréal)

Louigi Addario-Berry, Linan Chen, Luc Devroye, Bruce A. Reed (McGill)

Wei Sun, Xiaowen Zhou (Concordia)

Donald A. Dawson (Carleton)

ASSOCIATE MEMBERS

Andrew Granville (Montréal)

Dmitry Jakobson, Vojkan Jakšić (McGill)

Marco Bertola (Concordia)

QUANTACT ACTUARIAL AND FINANCIAL MATHEMATICS LABORATORY

Quantact is the name of the CRM Laboratory of Actuarial and Financial Mathematics, i.e., the area of mathematics concerned with problems in insurance and finance. The Laboratory members develop and use probabilistic and statistical methods to analyze issues having a financial impact on society. Quantact gathers professors from UQAM, Concordia University, the Université Laval, and the Université de Montréal.

The research interests of Quantact members include FADR insurance, actuarial statistics, actuarial finance, and mathematical finance, as well as the mathematics of risk and ruin theory. Here are a few of the themes studied by Quantact members: pricing and provisioning in FADR insurance; solvency of financial institutions; financial innovation in insurance (pricing and covering of variable annuities and market-linked insurance products); the modelling of longevity risk and mortality and its impacts on life insurance and pension schemes; the quantification of the impact of natural disasters and other extreme events; dependency models; measures of risk; models for the frequency and severity of disasters; stochastic control of risk processes and stochastic optimization; and the statistical analysis of big data in insurance.

HIGHLIGHTS

In 2014 Quantact became the CRM Actuarial and Financial Mathematics Laboratory. The laboratory results from the merging of the UQAM group (already called Quantact), a subgroup of the Statistics Laboratory, and other Québec researchers in actuarial and financial mathematics. During its first year as a CRM laboratory, Quantact continued to organize the Actuarial and Financial Mathematics Seminar as well as a seminar for graduate students. Quantact members are deeply involved in the activities of the Actuarial Science Section of the Statistical Society of Canada.

SEMINARS

Quantact members organize the Actuarial and Financial Mathematics Seminar and a student seminar.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014-2015 the members of Quantact supervised or cosupervised 3 undergraduate students, 37 M.Sc. students, 16 Ph.D. students, and 5 postdoctoral fellows.



DIRECTOR

Jean-François Renaud (UQAM)

REGULAR MEMBERS

Maciej Augustyniak, Manuel Morales (Montréal)

Alexandru Badescu, Jean-Philippe Boucher, Mathieu Boudreault, Arthur Charpentier, Alexandre Roch (UQAM)

Patrice Gaillardetz, José Garrido, Cody Hyndman, Mélima Mailhot (Concordia)

Hélène Cossette, Étienne Marceau, Mathieu Pigeon (Laval)

Chantal Labbé (HEC Montréal)

STATISTICS

Statistical methods and reasoning play an important role in the advancement of knowledge. Be it through surveys from sampling, the measure of socio-economic indicators, clinical trials to compare various biomedical treatments, or the study of the survival of an animal population in ecology, statistical methodology can be found everywhere in the sciences.

Recently statistics has undergone a revolution in its techniques and approaches. This revolution has been driven by the need to analyze very large data sets and data with more complex structure, and by the advent of powerful computers.

Statistical methodology is now addressing problems whose structure is very complex, such as the analysis of brain images or genome data, and new methodology (such as data mining) is being developed for large data sets. The computational aspect of statistics is thus becoming more and more important, but of course mathematics continues to be the foundation of statistics.

Statistics has many application areas and in particular the laboratory includes several researchers in biostatistics. One of the aims of the laboratory is to structure the Québec statistical community so that it can participate in the revolution mentioned above at a time when an important renewal of academic personnel is taking place. This structure allows the Québec community to participate in Canada-wide programs organized by the three Canadian mathematics institutes, as well as the newly created Canadian Statistical Sciences Institute (CANSSI). The laboratory is formed of the leaders of the Québec school of statistics, who work on topics such as statistical learning and neural networks, survey sampling, analysis of functional data, statistical analysis of images, dependence structures, Bayesian analysis, analysis of time series and financial data, and resampling methods.

HIGHLIGHTS

Laboratory members organized an important meeting in Montréal in December 2014, the CRM-CANSSI Workshop on “New Horizons in Copula Modeling” (see the section of the present report on “Other Activities”). Many members of the Statistics Laboratory were awarded honours or positions reflecting their expertise and international reputation. For instance Debbie Dupuis was invited to give a lecture in Canberra, Thierry Duchesne lectures in Halifax and Toronto, David Haziza lectures in Dijon and Rio de Janeiro, Éric Marchand a lecture in Tokyo, Bruno Rémillard a lecture at Oberwolfach, and Louis-Paul Rivest lectures at Oberwolfach and in Tokyo.

SEMINARS

The members of the Statistics Laboratory organize four seminar series: the McGill University Statistics Seminar; the Université Laval Statistics Seminar; the Université de Sherbrooke Statistics Seminar; and the Montréal Biostatistics Seminar. Altogether more than 90 researchers gave presentations within these four seminar series in 2014-2015; this is a testimony to the intense research activities taking place in the Statistics Laboratory.

STUDENTS AND POSTDOCTORAL FELLOWS

In 2014-2015 the members of the Statistics Laboratory supervised or cosupervised 122 M.Sc. students, 100 Ph.D. students, and 14 postdoctoral fellows.

DIRECTOR

Christian Genest (McGill)

REGULAR MEMBERS

Jean-François Angers, Mylène Bédard, Yoshua Bengio, Martin Bilodeau, Pierre Duchesne, David Haziza, Pierre Lafaye de Micheaux, Christian Léger, Alejandro Murua, François Perron (Montréal)

Debbie J. Dupuis, Bruno Rémillard (HEC Montréal)

Juli Atherton, Sorana Froda, Simon Guillotte, Fabrice Larribe, Geneviève Lefebvre, Brenda MacGibbon (UQAM)

Masoud Asgharian, Abbas Khalili, Aurélie Labbe, Erica E. M. Moodie, Johanna Nešlehová, Robert W. Platt, James O. Ramsay, Russell Steele, David A. Stephens, David B. Wolfson (McGill)

Yogendra P. Chaubey, Arusharka Sen (Concordia)

Belkacem Abdous, Anne-Sophie Charest, Thierry Duchesne, Lajmi Lakhel Chaieb, Louis-Paul Rivest (Laval)

Taoufik Bouezmarni, Éric Marchand, Sévérien Nkurunziza (Sherbrooke)

ASSOCIATE MEMBERS

Vahid Partovi Nia (Polytechnique Montréal)

Fateh Chebana (INRS-ETE)

Nadia Ghazzali (UQTR)

THE CRM PRIZES

Each year the CRM awards four prizes (among the eight important national prizes in the mathematical sciences): the CRM–Fields–PIMS Prize (awarded jointly by the three Canadian mathematics institutes); the Theoretical Physics Prize awarded jointly by the CRM and the Canadian Association of Physicists; the CRM–SSC Prize, awarded jointly by the CRM and the Statistical Society of Canada to a researcher at the beginning of his or her career; and the André Aisenstadt Prize, awarded by the CRM to a rising young Canadian star selected by the CRM International Scientific Advisory Committee.

THE 2015 CRM-FIELDS-PIMS PRIZE AWARDED TO KAI BEHREND

Professor Behrend is an internationally recognized leader in the field of algebraic geometry, whose contributions to the subject are noted both for their depth and scope. He has obtained fundamental results in the theory of algebraic stacks, Gromov–Witten theory, and the study of Donaldson–Thomas invariants. In particular, his pioneering works on the construction of a “virtual fundamental class” played a key role in laying the algebraic foundations of the Gromov–Witten theory. Later, he made a breakthrough in the study of the Donaldson–Thomas invariants by showing that, for certain spaces, the degree of the virtual fundamental class could be expressed as the topological Euler characteristic weighted by a natural constructible function, depending only on the intrinsic properties of the space. This function is now widely known as Behrend’s function. It allowed the use of motivic methods to compute Donaldson–Thomas invariants and made it possible to obtain their categorified and motivic versions, which is currently among the hottest trends in the subject. In his earlier work, Professor Behrend obtained an important generalization of the Lefschetz trace formula for algebraic stacks, presently known as Behrend’s trace formula. The ideas put forward by Kai Behrend have already proven to be immensely influential and will undoubtedly have a lasting impact on this area of mathematics.

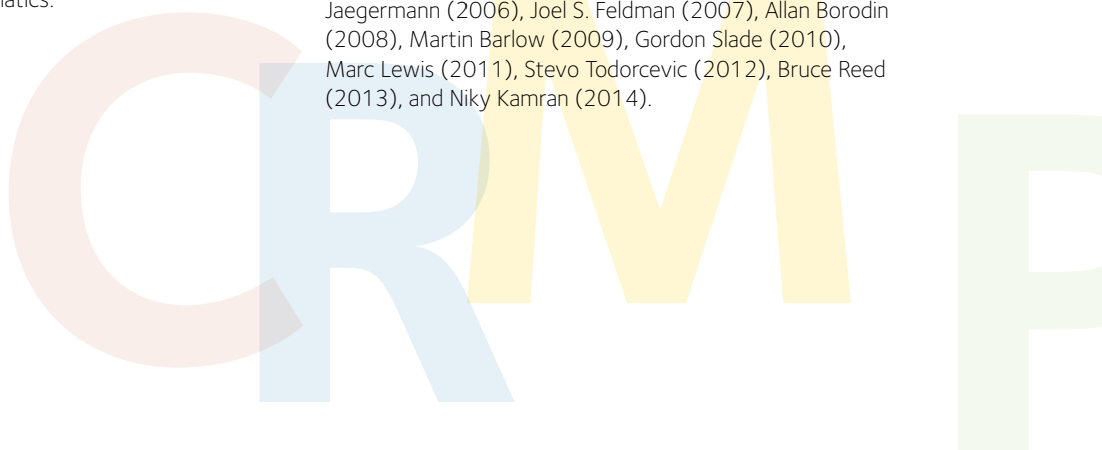


KAI BEHREND

Kai Behrend received a Ph.D. in 1991 at the University of California, Berkeley. He joined the faculty of the University of British Columbia in 1994. Professor Behrend has received numerous awards for his research, including the 2001 Coxeter–James Prize and the 2011 Jeffery–Williams Prize of the Canadian Mathematical Society, as well as an invitation to speak at the International Congress of Mathematicians in Seoul in 2014.

THE CRM-FIELDS-PIMS PRIZE

This prize was established in 1994 as the CRM–Fields Prize to recognize exceptional research in the mathematical sciences. In 2005 PIMS became an equal partner in the awarding of the prize and its name was changed to the CRM–Fields–PIMS Prize. A committee appointed by the three institutes chooses the recipient. The previous recipients of the prize are H.S.M. (Donald) Coxeter (1995), George A. Elliott (1996), James Arthur (1997), Robert V. Moody (1998), Stephen A. Cook (1999), Israel Michael Sigal (2000), William T. Tutte (2001), John B. Friedlander (2002), John McKay (2003), Edwin Perkins (2003), Donald A. Dawson (2004), David Boyd (2005), Nicole Tomczak–Jaegermann (2006), Joel S. Feldman (2007), Allan Borodin (2008), Martin Barlow (2009), Gordon Slade (2010), Marc Lewis (2011), Stevo Todorčević (2012), Bruce Reed (2013), and Niky Kamran (2014).





LOUIS-PIERRE ARGUIN

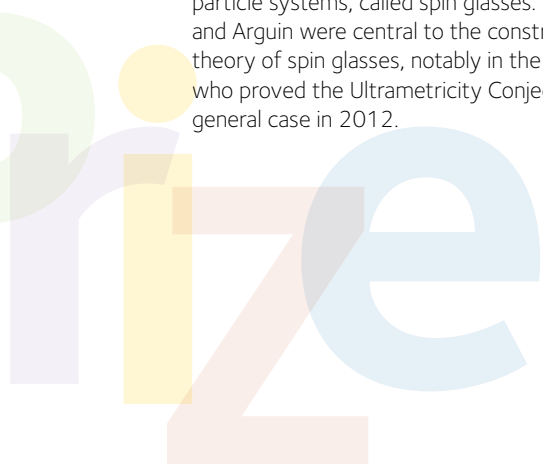
THE 2015 ANDRÉ AISENSTADT PRIZE AWARDED TO LOUIS-PIERRE ARGUIN

Dr. Arguin obtained his M.Sc. degree in physics at the Université de Montréal in 2002 under the supervision of Yvan Saint-Aubin and his Ph.D. in mathematics at Princeton University in 2007 under the supervision of Michael Aizenman. Arguin's research interests lie in probability theory and its applications to mathematical physics and other fields. One of his most spectacular breakthroughs came in a series of joint papers with Anton Bovier and Nicola Kistler on the extreme values of branching Brownian motion. This work has received considerable international recognition and was the subject of a Séminaire Bourbaki in March 2013. The impact of the methods developed by Arguin and his collaborators goes beyond probability theory. In particular Arguin, Belius, and Harper have applied this approach to probe the conjecture of Fyodorov, Hiary, and Keating stating that the maxima of the Riemann zeta function on a bounded interval of the critical line have statistics similar to those of branching Brownian motion.

In an earlier work with Aizenman, Arguin developed a new approach to a long-standing open problem in statistical mechanics now referred to as the Parisi Ultrametricity Conjecture. The conjecture is about a large class of interacting particle systems, called spin glasses. The ideas of Aizenman and Arguin were central to the construction of a rigorous theory of spin glasses, notably in the work of Panchenko, who proved the Ultrametricity Conjecture in the most general case in 2012.

THE ANDRÉ AISENSTADT PRIZE

Created in 1991, the André Aisenstadt Mathematics Prize is intended to recognize and reward research achievements in pure and applied mathematics by talented young Canadian mathematicians. This prize consists of a \$3,000 award and a medal. The recipient is chosen by the International Scientific Advisory Committee of the CRM. At the time of consideration, candidates must be Canadian citizens or permanent residents of Canada and no more than seven years from their Ph.D. The mathematician who is awarded this prize is invited to give a lecture at the CRM and present a summary of his work (published in the Bulletin du CRM). The previous recipients of the André Aisenstadt Prize are Niky Kamran (1992), Ian Putnam (1993), Michael Ward (1995), Nigel Higson (1995), Adrian S. Lewis (1996), Lisa Jeffrey (1997), Henri Darmon (1997), Boris Khesin (1998), John Toth (1999), Changfeng Gui (2000), Eckhard Meinrenken (2001), Jinyi Chen (2002), Alexander Brudnyi (2003), Vinayak Vatsal (2004), Ravi Vakil (2005), Iosif Polterovich (2006), Tai-Peng Tsai (2006), Alexander E. Holroyd (2007), Gregory G. Smith (2007), József Solymosi (2008), Jonathan Taylor (2008), Valentin Blomer (2009), Omer Angel (2010), Joel Kamnitzer (2011), Marco Gualtieri (2012), Young-Heon Kim (2012), Spyros Alexakis (2013), and Sabin Cautis (2014).





CHARLES GALE



THE 2015 CAP-CRM PRIZE AWARDED TO CHARLES GALE

The 2015 CAP-CRM Prize in Theoretical and Mathematical Physics was awarded to Charles Gale, from McGill University, for his distinguished original research contributions to three areas of theoretical nuclear physics: the determination of the equation of state from medium-energy heavy ion collisions; the use of photons, lepton pairs, and jets as probes of the hot and dense matter formed in high-energy heavy ion collisions; and the implementation of a state-of-the-art computer code for 3+1 dimensional second-order viscous relativistic fluid dynamics for heavy ion collisions.

Charles Gale carried out seminal work in theoretical subatomic physics, in particular in the field of relativistic nuclear collisions and of finite-temperature field theory. He made many original contributions to the knowledge of the dense nuclear matter equation of state, and to transport theory in nuclear reactions at high energies. He is well known for his pioneering work on the emission of electromagnetic radiation from the strongly interacting plasma formed in the relativistic collisions of heavy nuclei. His recent work is on 3+1 dimensional relativistic viscous hydrodynamics, an approach that has become the cornerstone of the modern modelling of relativistic nuclear collisions. Professor Gale has also co-authored an authoritative textbook on field theories at finite temperature, a text that has established itself as the standard reference in its field and is used by a wide spectrum of the astrophysics, nuclear, and particle physics communities.

THE CAP-CRM PRIZE

The CRM and the Canadian Association of Physicists (CAP) created in 1995, on the occasion of the 50th anniversary of the CAP, a joint prize for recognizing exceptional achievements in theoretical and mathematical physics. The prize consists of a \$2,000 award and a medal. The previous recipients of the prize are 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), Matthew Choptuik (2003), Jiří Patera (2004), Robert Myers (2005), John Harnad (2006), Joel S. Feldman (2007), Richard Cleve (2008), Hong Guo (2009), Clifford Burgess (2010), Robert Brandenberger (2011), Luc Vinet (2013), and Mark Van Raamsdonk (2014).





MATÍAS SALIBIÁN-BARRERA

THE 2014 CRM-SSC PRIZE AWARDED TO MATÍAS SALIBIÁN-BARRERA

The 2014 CRM-SSC Prize was awarded to Matías Salibián-Barrera of the University of British Columbia (UBC), one of the brightest and most accomplished young statisticians in Canada. He was born in Chile and grew up in Buenos Aires, Argentina. He obtained his Bachelor in Mathematics at the University of Buenos Aires, where he was introduced to statistics (robustness, in particular) by Victor Yohai, himself a major force in this field. Salibián-Barrera's doctoral dissertation was completed in 2000 at UBC under the supervision of Ruben Zamar. The thesis, entitled Contributions to the Theory of Robust Inference, blends mathematical theory and computational procedures in a sophisticated manner that has continued throughout his career. After graduation Salibián-Barrera was appointed Assistant Professor at Carleton University; in 2004 he returned to UBC where he is now Associate Professor. During his time at UBC he has also held Visiting Lectureships, designing and teaching short graduate-level courses at the Université libre de Bruxelles, Belgium, and at the University of Buenos Aires.

A remarkable feature of Salibián-Barrera's research is that his contributions are not only rigorously documented in good articles but also implemented in statistical freeware. He is well known and prized in the statistical community for his non-trivial implementation of state-of-the-art robust methods in R. His methodological contributions include the fast and robust bootstrap, uniform asymptotics for robust location and regression estimates, globally robust inference, robust smoothing, and robust functional data analysis. Complementing this, his computational work includes fast S- and fast tau-regression estimates, deep involvement with the construction of the S-plus "robust" library and the R-package "robustbase," linear clustering, and robust and sparse k-means. The fast and robust bootstrap introduced

in Salibián-Barrera's doctoral dissertation (and subsequently developed in several joint papers with S. Van Aelst and G. Willems) represents a breakthrough in robust inference and has been adapted for numerous other scenarios, in particular for longitudinal studies and unbalanced clustering by Alan Welsh (ANU) and collaborators.

Most proofs of asymptotic normality for robust procedures in the statistical literature use the unrealistic assumption of the validity of the central parametric model. This is unsatisfactory because robust methods are meant to be used with contaminated data. Salibián-Barrera's research deals with this problem and has produced very strong results on the uniform consistency and asymptotic normality in a neighbourhood of the central parametric model. His introduction, jointly with Victor Yohai, of the fast regression S-estimator and the subsequent development of the fast tau-estimator are important breakthroughs for the efficient computation of these regression estimates. Similar ideas have also been used to compute multivariate location estimators.

More recently, Salibián-Barrera has turned his attention to functional principal component analysis. Dimension reduction associated either with variable selection in regression or the approximation of covariance matrices is an essential part of addressing the problems encountered in high-dimensional data analysis. In a recent JASA paper Salibián-Barrera studies ways to find lower dimensional approximations that fit the functional data well and have minimum prediction error. Salibián-Barrera's contributions to the profession go beyond his research: he has served on the local organizing committee for the 2009 SSC meeting in Vancouver and on the SSC Board. He is also a valued Associate Editor for both *The Canadian Journal of Statistics* and *Computational Statistics and Data Analysis*.

THE CRM-SSC PRIZE

The SSC, founded in 1977, is dedicated to the promotion of excellence in statistical research and practice. The prestigious CRM-SSC Prize 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. The previous recipients of the CRM-SSC Prize are Christian Genest (1999), Robert J. Tibshirani (2000), Colleen D. Cutler (2001), Larry A. Wasserman (2002), Charmaine B. Dean (2003), Randy Sitter (2004), Jiahua Chen (2005), Jeffrey Rosenthal (2006), Richard Cook (2007), Paul Gustafson (2008), Hugh Chipman (2009), Grace Y. Yi (2010), Edward Susko (2011), Changbao Wu (2012), Derek Bingham (2013), and Fang Yao (2014).

THE CRM AND MATHEMATICAL EDUCATION

The mandate of the CRM is to foster the development of research in the mathematical sciences at all levels. For the CRM the training of young researchers, the promotion of mathematical research, and the development of mathematics teaching are very important endeavours. This is why the CRM supports (financially and otherwise) many activities and programmes in the area of mathematical education and training. A substantial part of the CRM activities are carried out in collaboration with the Institut des sciences mathématiques (ISM), which was created in 1991 and has eight partners: Bishop's University, Concordia University, McGill University, Université de Montréal, UQAM, UQTR, Université de Sherbrooke, and Université Laval. The ISM is financed by its partners and the Québec Ministry of Education. The ISM mission consists of: coordinating and harmonizing the mathematics graduate programmes of Québec universities; fostering excellence in training; supporting research through scholarships and prizes; and stimulating the interest of young people for the mathematical sciences (in particular through the dissemination of mathematical knowledge among teachers, young people, and the general public). In 2014–2015 the director of the ISM was Professor Christian Genest (McGill University).

CRM-ISM POSTDOCTORAL FELLOWSHIPS

The CRM-ISM Postdoctoral Fellowships allow promising young researchers to devote most of their time to their research work. These postdoctoral fellows are chosen in a rigorous and very competitive manner: only one applicant out of 40 is selected. The postdoctoral fellows play a crucial role in our universities, by collaborating with mature researchers, bringing new ideas from other great centres of mathematical research, and organizing working groups on cutting-edge topics.

2014–2015 POSTDOCTORAL FELLOWS

Here is the list of fellows, along with the institution and year of their Ph.D. We also give their research areas and the names of the mathematicians who supervise them at the CRM. Note that the first five fellows work in diverse fields not necessarily related to the 2014–2015 thematic programme, while the last four are associated with this thematic programme.

Stephan Ehlen

Ph.D.: TU Darmstadt (2013)

Supervisors: Henri Darmon and Eyal Goren (McGill)

Research area: modular forms and arithmetic geometry



CHRISTIAN GENEST

Alastair Irving

D.Phil.: Oxford (2014)

Supervisors: Andrew Granville and Dimitrios Koukoulopoulos (Montréal)

Research area: analytic number theory

Amy Pang

Ph.D.: Stanford (2014)

Supervisors: François Bergeron, Christophe Hohlweg, Christophe Reutenauer, and Franco Saliola (UQAM)

Research area: interaction of algebraic combinatorics and probability

Boaz Slomka

Ph.D.: Tel Aviv (2014)

Supervisors: Alina Stancu (Concordia) and Dmitry Jakobson (McGill)

Research area: asymptotic convex geometry

Weiwei Wu

Ph.D.: Michigan State (2012)

Supervisors: Octav Cornea and François Lalonde (Montréal)

Research: topology and geometry of symplectic manifolds

Daniel Barrera

Ph.D.: Lille 1 (2013)

Supervisors: Adrian Iovita (Concordia), Payman Kassaei (McGill), and Andrew Granville (Montréal)

Research area: p -adic arithmetic of geometric objects

Sary Drapeau

Ph.D.: Paris Diderot (2013)

Supervisor: Andrew Granville (Montréal)

Research area: distribution and multiplicative properties of integers with relatively small prime factors

Kevin Ventullo

Ph.D.: UCLA (2014)

Supervisor: Henri Darmon (McGill)

Research area: Iwasawa theory, p -adic L -functions, modular forms, and Galois representations

Yongqiang Zhao

Ph.D.: Waterloo (2013)

Supervisors: Henri Darmon (McGill), Chantal David (Concordia), and Andrew Granville (Montréal)

Research area: arithmetic geometry

Pleins feux sur la lumière

La lumière : un éclairage moderne

UNDERGRADUATE SUMMER SCHOLARSHIPS

In collaboration with the CRM and the ISM professors, the ISM awards summer scholarships to promising undergraduates who want to do research during the summer and plan to study mathematics at the graduate level. These undergraduates are supervised by postdoctoral fellows, who in general are supervising students for the first time. The reader will find below the list of the undergraduate scholars for the summer of 2014.

Xuesi Cai (McGill)

Scholarship co-financed by Pengfei Guan

Supervisor: Yiyang Xu

Topic: Geometric Analysis

Jaël Champagne-Gareau (UQAM)

Scholarship co-financed by Olivier Collin

Supervisor: Michael Bradenbursky

Topic: Introduction aux courbes algébriques

François De L'Isle (Montréal)

Scholarship co-financed by Iosif Polterovich

Supervisor: Asma Hassannezhad

Topic: Un problème spectral inverse pour l'opérateur Dirichlet-Neumann

Ryan Gibara (Concordia)

Scholarship co-financed by Galia Dafni

Supervisor: Linan Chen

Topic: Optimal Transport on Wiener Space

Geneviève Provost (Montréal)

Scholarship co-financed by Pavel Winternitz

Supervisor: Danilo Riglioni

Topic: Systèmes superintégrables pour l'interaction de deux particules avec spin 1/2

Sarah Sekheri (UQAM)

Scholarship co-financed by Franco Saliola

Supervisor: Nathan Williams

Topic: Provide Exact Enumerations for Quantities Related to a Geometric Embedding of Grassmannians

SCIENTIFIC ACTIVITIES JOINTLY ORGANIZED OR SUPPORTED BY THE CRM AND THE ISM

The CRM and the ISM jointly organize or support several scientific activities. We have mentioned elsewhere in this report the Séminaire de mathématiques supérieures and the Colloque de mathématiques CRM-ISM. Among other activities organized or supported in collaboration with the ISM, let us mention the "XVIII^{ème} Colloque panquébécois des étudiants de l'ISM" (HEC Montréal, May 15-17, 2015). Also the CRM and the ISM gave financial support to the "58^{ème} Congrès de l'Association mathématique du Québec" (Cégep régional de Lanaudière à L'Assomption, October 3-4, 2014). The CRM and the ISM jointly oversee the *Annales mathématiques du Québec*, a journal that has been the international showcase of the Québec mathematical community for three decades.

PROMOTION OF THE MATHEMATICAL SCIENCES BY THE CRM AND THE ISM

The Accromath magazine, whose editor-in-chief is André Ross, is produced by the ISM and its production costs are defrayed in part by the CRM. The magazine has two issues per year and is distributed free of charge in all Québec high schools and cégeps. The goal of Accromath is to stimulate the high school and cégep teachers by providing them with material that is topical and up-to-date. Accromath consists of articles on the most recent developments in mathematics and their applications, as well as articles on the history of mathematics or links between mathematics and the arts. Accromath has been awarded several prizes (both for its contents and graphic design). The CRM and the ISM jointly support the "Sciences et mathématiques en action" programme (created by Professor Jean-Marie De Koninck) and the "Association québécoise des jeux mathématiques."

GRADUATE STUDENTS SUPERVISION

The CRM members supervise a large number of graduate students. We now give information on the students supervised by CRM members who graduated in 2014–2015. The name of the student is followed by the name of his or her supervisor (or names of his or her supervisors). Some names may be missing from this list, because we have only included those that have been brought to our attention. Here is the list of students who obtained their Ph.D. in 2014–2015.

STUDENTS WHO OBTAINED THEIR PH.D. IN 2014–2015

Ayi Ajavon (François Perron)
 Olga Balkanova (Chantal David and Andrew Granville)
 Li Baoqiang (Frédéric Lesage)
 Cyril Joël Batkam (Tomasz Kaczynski)
 Louis Beaudet (Thomas Brüstle)
 Héctor J. Blandin Noguera (François Bergeron and Franco Valentino Saliola)
 Nicolas Boulanger-Lewandowski (Yoshua Bengio and Pascal Vincent)
 Sophie Burill (Marni Mishna)
 Raquel Cabral (Galia Dafni)
 Luca Candelori (Henri Darmon)
 Laurent Delisle (Véronique Hussin)
 Toktam Dinevari (Marlène Frigon)
 Rodrigo Farinha Matias (Chris J. Cummins and John McKay)
 Anusar Farooqui (Niky Kamran and Prakash Panangaden)
 Sepideh Farsinezhad (Masoud Asgharian and Russell Steele)
 Ana Figueras Best (David B. Wolfson)
 Jérôme Fortier (Srečko Brlek)
 Vincent Genest (Luc Vinet)
 Manuela Girotti (Marco Bertola)
 Mark Goldsmith (Vašek Chvátal)
 Clément Gomez (Henri Darmon)
 Ian Goodfellow (Yoshua Bengio and Aaron Courville)
 François Grégoire-Lacoste (Alain Vinet)
 Daphna Harel (Russell Steele and David A. Stephens)
 Mostafa Hassanlou (Javad Mashregi)
 Kevin Henriot (Andrew Granville and Régis de la Bretèche)
 Bailey Jacobson (Pedro Peres-Neto)
 Muath Karaki (Javad Mashregi and Emmanuel Fricain)
 Martin Klimes (Christiane Rousseau)
 Nedialko Krouchev (Alain Vinet and Mohamad Sawan)
 Patrick Lacasse (André Fortin and Michel Fortin)
 Bundit Laekhanukit (Adrian Vetta)
 Sophie Léger (André Fortin)
 Arnaud Lepage-Jutier (Alexander Maloney)
 Kodjo Essonana Magnani (Ibrahim Assem and Vasilisa Shramchenko)
 Mona Maneshi (Christophe Grova)
 Justin N. Marleau (Michel Loreau and Frédéric Guichard)
 Zeinab Mashregi (Christian Léger and David Haziza)

Atefeh Mohajeri Moghaddam (Bruce Shepherd and Olga Kharlampovich)
 Lenka Motlochová (Jiří Patera)
 Ndouné Ndouné (Ibrahim Assem and Vasilisa Shramchenko)
 Hassan Omidirouzi (Manuel Morales and Méline Mailhot)
 Razvan Pascanu (Yoshua Bengio)
 Hector Pasten (M. Ram Murty)
 Marco Antonio Pérez Bullones (André Joyal)
 Lloyd Peters (Antonio Lei)
 Lisa Powers (Rustum Choksi and Jean-Christophe Nave)
 Jyoti Prakash Saha (Olivier Fouquet and Adrian Iovita)
 Ashok Rajaraman (Cédric Chauve)
 Samuel Ranellucci (Alain Tapp)
 Samir Raouafi (Thomas J. Ransford)
 Mariolys Rivas (Lea Popovic)
 Tom Rohmer (Taoufik Bouezmarni and Ivan Kojadinovic)
 Azar Salami (Hugo Chapdelaine and Michael Lau)
 Fatemeh Shohoudi Mojdehi (David B. Wolfson and Masoud Asgharian)
 Clarence Simard (Bruno Rémillard)
 Benjamin Herbert Smith (Jacques Hurtubise)
 Lara-Simone Suarez Lopez (Octav Cornea)
 Behrouz Taji (Peter Russell, Jacques Hurtubise, and Steven Shin-Yi Lu)
 Luiz Takei (Eyal Z. Goren and Henri Darmon)
 Denis Talbot (Geneviève Lefebvre and Juli Atherton)
 Yannic Vargas Lozada (Franco V. Saliola and Christophe Reutenauer)
 Baoyong Wang (David Sankoff)
 Malik Younsi (Thomas J. Ransford)
 Younes Zerouali Boukhal (Jean-Marc Lina)
 Foued Zitouni (Mario Lefebvre)

STUDENTS WHO OBTAINED THEIR M.Sc. IN 2014–2015

Sidi Allal Aissaoui (Mhamed Mesfioui and Christian Genest)
 Raghad Al-Nouri (Vestislav Apostolov)
 François Amalega Bitondo (Abraham Broer)
 Yogesh Anbalagan (Adrian Vetta)
 Jean Auger (Michael Lau)
 Shahab Azarfar (Dmitry Korotkin)
 Sandra Aziz (Jean-François Angers)
 Jessica Bach (Louis-Paul Rivest)
 Patrick Baril Robichaud (Alain Tapp)
 Aryan Bayani (Geña Hahn and Gert Sabidussi)
 Émilie Beaulieu-Ouellet (Frédéric Lesage)
 Océane Bénaiteau (Manuel Morales)
 Karl-Alexander Berg-Brisebois (Olivier Collin)
 Vanessa Bergeron-Laperrière (David A. Stephens)
 Elsa Bernatchez (Lajmi Lakhil Chaieb)

Anne-Marie Bizier (Debbie J. Dupuis)
 Nicolas Bouchard (Matilde Lalín)
 Maxime Caron (Anne-Sophie Charest)
 Melissa Caron (David L. Buckeridge)
 Pierre-Luc Carrier (Aaron Courville and Yoshua Bengio)
 Marcel Celaya (Bruce Shepherd)
 Valentine Chiche-Lapierre (Galia Dafni and Chantal David)
 Romain-Aimé Chipouwoh Kuela (Line Baribeau)
 Marie-Pier Côté (Christian Genest)
 Janie Coulombe (Christian Léger)
 Guillaume Couture-Piché (Jean-Philippe Boucher)
 Armand Dadoun (Alexandre Roch)
 Katherine Daignault (Russell Steele and Robert W. Platt)
 Oana Alexandra Damian (Pierre Duchesne)
 Haridas Kumar Das (Syed Twareque Ali)
 Jean-Philippe Day-Michaud (Jean-François Renaud and Christophe Reutenauer)
 Sarah Desmeules (Thomas J. Ransford)
 Étienne Doucet (Jean-Philippe Boucher)
 Florian Duquerroix (Octav Cornea)
 Vincent Duranceau-Desmarais (Bruno Rémillard)
 Rabi Fares (Wei Sun)
 Michele Fornea (Olivier Fouquet and Adrian Iovita)
 Dominik Francoeur (Virginie Charette)
 Colleen Fuller (David L. Buckeridge)
 Rémi Gagné (Virginie Charette and Ibrahim Assem)
 Robert Graham (Mikaël Pichot)
 Ievgenii Grebennikov (Johanna Nešlehová and Christian Genest)
 Iban Harlouchet (Pierre Lafaye de Micheaux)
 Huining Hu (Adrian Vetta)
 Omar Khalil (Louigi Addario-Berry)
 Ali Khardani (Steven Patrick Boyer)
 Yeena Komi Kpeglo (Christophe Reutenauer)
 Hubert Lacombe (Jean-Marc Lina)
 Karine Lacourse (Jean-Marc Lina)
 Jean-Benoît Lalanne (Paul François)
 Benjamin Landon (Vojkan Jakšić and Robert Seiringer)
 David Lapierre (Robert G. Owens)
 Andréanne Lapointe (Luc Vinet)
 Olivier Larocque (Matilde Lalín)
 Joël Lefebvre (Frédéric Lesage)
 Jean-Michel Lemay (Luc Vinet)
 Alexandre Lemire Paquin (Eyal Z. Goren and Henri Darmon)
 Nicholas Léonard (Yoshua Bengio and Aaron Courville)
 Vincent Létourneau (Octav Cornea)
 Christopher Leung (Bruno Rémillard)
 Dmytro Liashenko (Javad Mashreghi)
 Amadou Makhtar Tall (Alexandre Blondin Massé)
 Erika Maldonado (Mathieu Boudreault)
 Marc-Adrien Mandich (Vojkan Jakšić and Robert Seiringer)
 Kelelekela Mbuyi (Lajmi Lakhali Chaieb)
 Evan McDonough (Robert Brandenberger)
 Mehran Moghtadai (Patrice Gaillardetz)

Leta Montopoli (Dmitry Jakobson and Mikaël Pichot)
 Patrick Aaron Moore (Chantal David and Benoît Larose)
 Émilie Moutran (Pierre Duchesne)
 Andrei Munteanu (Debbie J. Dupuis)
 Bassirou Ndao (Manuel Morales)
 Hongwei Niu (Shiping Liu)
 Fidèle Niyukuri (Jacques Bélair)
 Giulio Orecchia (Sebastiaan Johan Edixhoven and Adrian Iovita)
 Nicolas Ortiz (Manuel Morales)
 Frédéric Ouimet (Louis-Pierre Arguin and Pierre Lafaye de Micheaux)
 Essaïd Oussaid (Christophe Reutenauer and Juli Atherton)
 Frédéric Paquin-Lefebvre (Jacques Bélair)
 Sung Chul Park (Pengfei Guan)
 Laurent Pelletier (Claude Bélisle)
 Hélène Péloquin-Tessier (Iosif Polterovich)
 Samuel Perreault (Étienne Marceau and Hélène Cossette)
 Joe Pharaon (Abraham Boyarsky and Pawel Góra)
 Caroline Presseau (Maxime Descoteaux)
 Prokopis Prokopiou (Peter Edwin Caines)
 Alex Provost (Olivier Collin)
 Emmanuelle Renaud (Kevin Whittingstall and Maxime Descoteaux)
 Alexandre René (Alejandro Murua)
 Martin Rivard-Cooke (Damien Roy)
 Marco Robado (Christophe Reutenauer)
 Laurent Robert-Veillet (Jérémy Rostand and André Fortin)
 Shabnam Saberi (Yves Goussard and Alain Vinet)
 Alhassane Seydou Sall (Juli Atherton)
 Alexis Scemama (Manuel Morales)
 Maxime Scott (Olivier Collin)
 François Séguin (Henri Darmon)
 Boyan Semerdjiev (Arusharka Sen)
 Nicolas Simard (Henri Darmon)
 Jian Tao (José Garrido)
 Selim Tawfik (Vestislav Apostolov)
 Yano Claudia Tchatchouang (Alain Vinet)
 Elliott Tixier (Stéphane Étienne and Dominique Pelletier)
 Linda Johana Torres Celis (Pierre Duchesne)
 Élise Tremblay (Alain Vinet)
 Olivier Trottier (Keshav Dasgupta)
 Daniel Tufcea (Paul François)
 Kristofer Tziritas (Jean-François Renaud and Geneviève Lefebvre)
 Audrey-Anne Vallée (David Haziza)
 Ivan Véga (Alain Vinet)
 Mariia Volodymyr Samoilenko (Geneviève Lefebvre and Lucie Blais)
 Mianbo Wang (Yogendra P. Chaubey)
 Ariane Romaine Weber (Srečko Brlek)
 Mohamad Wehbi (Alain Vinet)
 Ahmed Zerouali (Frédéric Rochon)
 Chuan Chuan Zhang (Louis G. Doray)
 Hui Rong Zhu (Yogendra P. Chaubey)
 Mariem Zouari (Alexandre Roch)

THE CRM PARTNERSHIPS

Although the CRM is primarily concerned with mathematical research and training conducted within Québec, its activities are part of a broad framework and it collaborates with many partners to fulfill its mission and ensure that the research carried out in Québec is of international calibre.

CANADIAN PARTNERSHIPS

On the Canadian scene the most important partnership of the CRM is the one with the two other Canadian mathematical institutes, i.e., the Fields Institute for Research in Mathematical Sciences (FI), based in Toronto, and the Pacific Institute for the Mathematical Sciences (PIMS) in the West. The three institutes coordinate their scientific activities (particularly their thematic programmes) and have carried out several projects together, including the creation of networks such as Mitacs (see below) and the creation of the CRM-Fields-PIMS Prize. The three institutes also support some activities of the professional associations in the mathematical sciences and give some financial support to the Atlantic Association for Research in the Mathematical Sciences (AARMS), founded in 1996 to encourage and promote research in the mathematical sciences in the Atlantic provinces. The three institutes also support the Canadian Statistical Sciences Institute (CANSSI), whose aim is to develop statistical sciences in Canada through attracting new researchers to the field, increasing the points of contact among researchers nationally and internationally, and fostering collaborations with other disciplines and organizations. Finally the CRM is a partner of the Banff International Research Station (BIRS), which organizes workshops in mathematics all year round.

INTERNATIONAL PARTNERSHIPS

The CRM members have many fruitful collaborations with French researchers, in particular those working at the Centre national de la recherche scientifique (CNRS), the Institut national de recherche en informatique et automatique (INRIA), and the Institut national de la santé et de la recherche médicale (INSERM). The CRM has signed a formal agreement with the ALGANT consortium (Algebra, Geometry, Number Theory) within the Erasmus Mundus network of the European Union. This agreement stimulates exchanges and joint supervision of graduate students. In 2010 the CRM and eleven other partners signed an agreement for the exchange of researchers with SISSA (International School for Advanced



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Studies, in English), a graduate studies university based in Trieste, Italy. The CRM also has two formal agreements with the Tata Institute of Fundamental Research (TIFR), a prestigious Indian institution: an agreement with the TIFR Centre for Applicable Mathematics (in Bangalore) and another with the TIFR centre in Mumbai. Finally we mention that the National Science Foundation (NSF) of the United States provides some financial support for almost every thematic programme organized by the CRM.

On March 6, 2015, Odile Marcotte (CRM Deputy Director) signed two agreements during the visit in France of the Québec premier, Dr. Philippe Couillard. The first agreement was signed with the Institut des Hautes Études Scientifiques (IHES) and the second one with the Institut Henri Poincaré (IHP). Odile Marcotte signed them on behalf of the CRM because Luc Vinet, CRM Director, could not travel to France at that time.

THE UNITÉ MIXTE INTERNATIONALE (UMI) OF THE CNRS AT THE CRM

A few years ago the Centre National de la Recherche Scientifique (CNRS) in France decided to create at the CRM a so-called UMI (i.e., a research unit outside France itself). The official name of this UMI is "Centre de recherches mathématiques – UMI 3457" and it was inaugurated in October 2011. Thanks to Laurent Habsieger, UMI director since 2011, this UMI has been extremely successful. The UMI supports financially long or short visits to the CRM by French researchers; it also supports visits to France by Québec researchers who spend a few weeks in France or are given temporary positions. The UMI provides financial support for meetings and workshops, either directly or through the reimbursement of the lecturers' expenses (for instance). In this manner the UMI supports the activities of the CRM thematic programmes and other activities.

Here is the list of French researchers who made long visits to the CRM and have thus stimulated the research of their Québec colleagues in 2014–2015: Gaël Rémond, Rachel Taillefer, Karim Kellay, Laurent Vuillon, Laurent Bruneau, Frédéric Naud, Yan Pautrat, Carl Tipler, Christophe Delaunay, Jean-Pierre Gazeau, Jacques Tilouine, Pierre Charollois, Mathieu Anel, Florin Avram, Emmanuel Royer, Igor Reider, and Jie Wu. Here are the Québec researchers who made visits in France: Dmitry Jakobson, Chantal David, Laurent



Partnerships

Habsieger, Alexey Kokotov, Eric Hanson, and Renaud Raquépas. We note that the applications by Québec researchers are fewer than the applications by French researchers, since the Québec researchers usually hold individual research grants. The participation of Québec researchers to the UMI, however, allows them to apply for and receive grants from the Agence nationale de la recherche (ANR).

To conclude we mention that the UMI was evaluated by the CNRS in 2015. The CNRS management sent a delegation to Montréal for a site visit that took place on April 7, 2015. Of course the CNRS decided to continue its support of the UMI, on account of its tremendous success.

ACADEMIC PARTNERS

The CRM has six academic partners: the Université de Montréal, McGill University, UQAM, Concordia University, the Université Laval, and the Université de Sherbrooke. The Université de Montréal has supported the CRM in a consistent manner over the years: in particular it provides the CRM with the equivalent (in teaching releases) of five full-time professors. The CRM offers teaching releases to professors from other Montréal universities and also teaching releases associated with its thematic programmes. Finally the Department of Mathematics and Statistics of the University of Ottawa became a partner of the CRM in 2003. The CRM finances teaching releases so that University of Ottawa researchers can work in the CRM laboratories and take part in its scientific activities. The CRM also supports postdoctoral fellows at the University of Ottawa and finances the CRM-University of Ottawa Distinguished Lecture Series, which features talks by prominent mathematicians from Canada and abroad on topics at the forefront of mathematical research. In 2014–2015 there were four lectures within that series. They were given respectively by Yuri Tschinkel (Courant Institute) on September 5, 2014, David Vogan (MIT) on September 19, 2014, Stanislaw Lech Woronowicz (Warsaw) on February 6, 2015, and Jeffrey Rosenthal (Toronto) on May 1st, 2015.

COLLABORATIONS WITH RESEARCH NETWORKS

The CRM has created, on its own or with other institutes, research networks that promote collaborations in the mathematical sciences between universities and industry. In 1997 the CRM (whose director was Luc Vinet) created the Network for Computing and Mathematical Modeling (ncm_2), a consortium of research centres in the Montréal area. The ncm_2 , which was funded by NSERC, was able to respond to

the needs of industry in a wide variety of fields related to computing and mathematical modelling. At the present time it allows four research centres (the CRM, GERAD, CIRRELT, and CIRANO) to fund joint projects in the mathematical sciences.

The three Canadian mathematical institutes (the CRM, the Fields Institute, and PIMS) launched the Mitacs network in 1999, thanks to a grant from the Canadian government. The objective of Mitacs, the only network of centres of excellence in the mathematical sciences, was to channel Canadian efforts in designing, applying, and commercializing new mathematical tools and methodologies within the framework of a world-class research programme. Mitacs has enjoyed a tremendous success; in particular it has involved up to 300 researchers and 600 students in around 50 Canadian universities. Recently Mitacs has broadened the scope of its activities and the “mathematics” section of Mitacs has been taken over by the Mprime network from 2011 to 2014. As mentioned before, the creation and fostering of CRM/industry partnerships is now taking place within the framework of the Institutes Innovation Platform (IIP), a project of the three Canadian mathematics institutes funded by NSERC.

Some CRM researchers take part in the activities of other networks, for instance Thierry Duchesne (who takes part in the Avahan-India AIDS Initiative), Gilles Brassard and Yoshua Bengio (who both take part in programs of the Canadian Institute for Advanced Research), and four PhysNum researchers (Maxime Descoteaux, Christophe Grova, Frédéric Lesage, and Jean-Marc Lina), who are members of the Québec Bio-imaging Network.

COLLABORATIONS WITH PROFESSIONAL SOCIETIES

The CRM and the other Canadian mathematical institutes give some financial support for the organization of the meetings of Canadian societies in the mathematical sciences. In 2014–2015 the CRM supported the 2014 Summer Meeting of the Canadian Mathematical Society (Winnipeg, June 5–8, 2014), the 2014 Winter Meeting of the CMS (Hamilton, December 6–9, 2014), the 2014 Annual Meeting of the Statistical Society of Canada (Toronto, May 25–28, 2014), and the 2014 Annual Meeting of the Canadian Applied and Industrial Mathematics Society (Saskatoon, June 22–26, 2014). Moreover the CRM supported the “Connecting Women in Mathematics Across Canada” Conference, held at the Banff International Research Station (BIRS) on October 3–5, 2014.



THE PUBLICATIONS OF THE CRM

Publications are an important component of the CRM contribution to the dissemination of research in the mathematical sciences. The CRM has two long-standing series published in collaboration with the American Mathematical Society (AMS): the *CRM Monograph Series* and the *CRM Proceedings* (formerly *CRM Proceedings and Lectures Notes*, recently included in *Contemporary Mathematics*). Springer publishes and distributes the *CRM Series in Mathematical Physics*, and a few titles from the CRM were included in its *Lecture Notes in Statistics* series. Although most of the books issued by the CRM are now to be found in these various series, the CRM also publishes and distributes, in French and in English, through *Les Publications du CRM*, monographs, proceedings, and lecture notes. In addition the CRM occasionally takes part in joint projects with various publishers and distributes preprints of the articles written by its researchers.



BOOKS PUBLISHED IN 2014 AND 2015

BOOKS PUBLISHED IN 2014 AND 2015

Philippe Poulin, *Leçons d'analyse classique: Exposition d'un cours fait par Paul Koosis à l'Université McGill*, Montréal, CRMM/36, 2015

Fritz Hörmann, *The Geometric and Arithmetic Volume of Shimura Varieties of Orthogonal Type*, CRMM/35, 2014

Leonid Polterovich and Daniel Rosen, *Function Theory on Symplectic Manifolds*, CRMM/34, 2014

CRM PROCEEDINGS (CONTEMPORARY MATHEMATICS SUBSERIES)

Alina Cojocaru, Chantal David and Francesco Pappalardi (eds.), *SCHOLAR—a Scientific Celebration Highlighting Open Lines of Arithmetic Research*, CONM/655, 2015

Carlo Gasbarri, Steven Lu, Mike Roth and Yuri Tschinkel (eds.), *Rational Points, Rational Curves, and Entire Holomorphic Curves on Projective Varieties*, CONM/654, 2015

Javad Mashreghi, Emmanuel Fricain and William Ross (eds.), *Invariant Subspaces of the Shift Operator*, CONM/638, 2015

Pierre Albin, Dmitry Jakobson and Frédéric Rochon (eds.), *Geometric and Spectral Analysis*, CONM/630, 2014

S. Ejaz Ahmed (ed.), *Perspectives on Big Data Analysis: Methodologies and Applications*, CONM/622, 2014

CRM SERIES IN MATHEMATICAL PHYSICS

André D. Bandrauk, Emmanuel Lorin, and Jerome V. Moloney (eds.), *Laser Filamentation – Mathematical Methods and Models*, 2016

GOVERNANCE AND SCIENTIFIC GUIDANCE

The CRM structure consists of a Board of Directors, an Assembly of Members, an International Scientific Advisory Committee, a Local Scientific Committee, a Management Committee, and a Committee of Directors of Laboratories. Here are the members of these committees for 2014–2015 (except for the directors of laboratories, already mentioned in a previous section).

BOARD OF DIRECTORS

The Board of Directors is composed of:

The Director (ex officio);

A member of the Management Committee nominated by the Board for a two-year mandate;

Two regular CRM members nominated by the Assembly for three-year mandates, normally renewable once;

A Laboratory Director, nominated by the Committee of Directors of Laboratories for a two-year mandate, normally renewable once;

The Chair of the International Scientific Advisory Committee;

The Vice-Principal, Research, of each of the main partner universities of the CRM; and

A Vice-Principal, Research, of one of the other partner universities of the CRM, chosen by these universities on a rotating basis for a two-year mandate.

In 2014–2015 the Board included Gérard Ben Arous (Chair of the International Scientific Advisory Committee), François Bergeron (UQAM), Graham Carr (Vice-Principal, Research, Concordia University), Sophie D'Amours (Vice-Principal, Research, Université Laval), Christian Genest (McGill University), Jacques Hurtubise (representing the Vice-Principal, Research, McGill University), Odile Marcotte (CRM Deputy Director), Yves Mauffette (Vice-Principal, Research, UQAM), Christiane Rousseau (Université de Montréal), Geneviève Tanguay (Vice-Principal, Research, Université de Montréal), and Luc Vinet (CRM Director).

Iosif Polterovich (Université de Montréal) and Galia Dafni (Concordia University), Deputy Directors, were invited members of the Board.



IOSIF POLTEROVICH



GÉRARD BEN AROUS

INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE

The International Scientific Advisory Committee (ISAC) consists of outstanding Canadian or foreign researchers, who are either mathematicians or scientists with close links to the mathematical sciences. The main task of the Committee is to make recommendations on the general scientific orientations of the CRM and give advice on proposed scientific activities. In 2014–2015 the committee was chaired by Gérard Ben Arous (Courant Institute) and also included Lia Bronsard (McMaster University), Stephen E. Fienberg (Carnegie Mellon University), Edward Frenkel (University of California, Berkeley), Mark Goresky (Institute for Advanced Study), Laurent Habsieger (CNRS), Claude Le Bris (École des Ponts ParisTech), Dusa McDuff (Columbia University), Duong Phong (Columbia University), Claus Michael Ringel (Universität Bielefeld), and Luc Vinet (CRM Director).

Geneviève Tanguay (Vice-Principal, Research, Université de Montréal) was an ex officio member of ISAC. Galia Dafni, Odile Marcotte, and Iosif Polterovich (all three Deputy Directors of the CRM) were invited members of ISAC.

LOCAL SCIENTIFIC COMMITTEE

In 2014–2015 the Local Scientific Committee consisted of Vestislav Apostolov (UQAM), Octav Cornea (Montréal), Jean-Philippe Lessard (Laval), Erica E. M. Moodie (McGill), Lea Popovic (Concordia), Luc Vinet (CRM Director), and Daniel T. Wise (McGill).

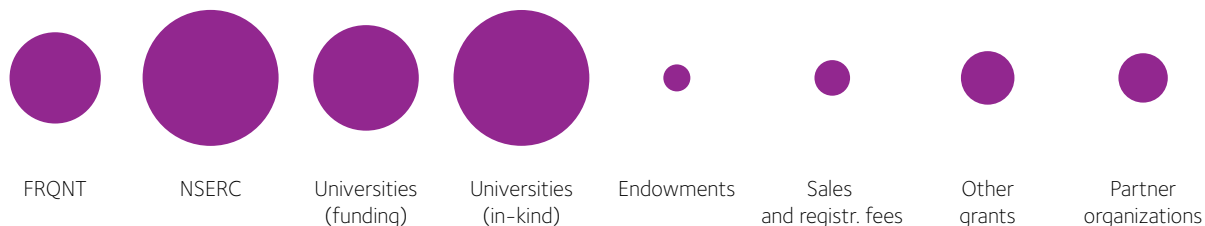
MANAGEMENT COMMITTEE

The Management Committee of the CRM consists of: Luc Vinet (Université de Montréal, mathematical physics), Director of the CRM; Galia Dafni (Concordia University, harmonic analysis), Deputy Director – Publications; Odile Marcotte (UQAM and GERAD, combinatorial optimization), Deputy Director – Partnerships; and Iosif Polterovich (Université de Montréal, geometric spectral theory), Deputy Director – Scientific Programs.

THE CRM IN NUMBERS

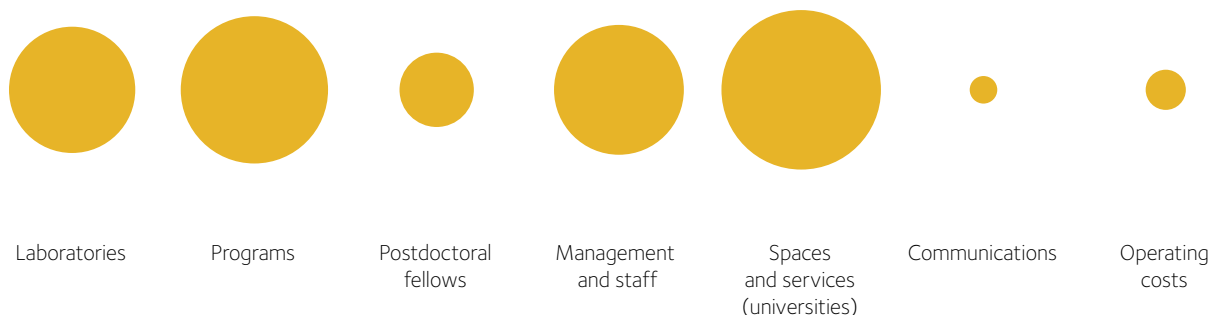
SOURCES OF FUNDING IN 2014-2015 IN THOUSANDS OF \$

FRQNT	605
NSERC	1,343
Universities (funding)	809
Universities (in-kind)	1,340
Endowments	53
Sales and registr. fees	92
Other grants	208
Partner organizations	177
	4,627

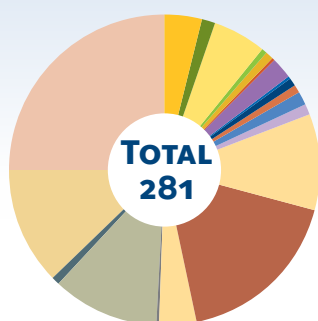


USE OF FUNDS IN 2014-2015 IN THOUSANDS OF \$

Laboratories	840
Programs	1,143
Postdoctoral fellows	291
Management and staff	888
Spaces and services (universities)	1,340
Communications	40
Operating costs	85
	4,627

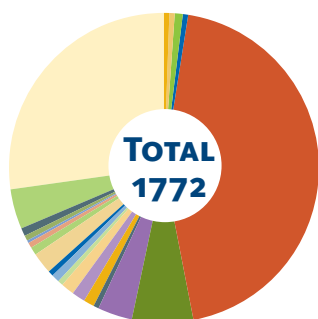


INSTITUTIONAL AFFILIATION OF CRM MEMBERS



University of Ottawa	5	Québec, Colleges	4
McGill University	69	INRS-ETE	2
Université Laval	33	HEC Montréal	2
Université du Québec à Trois-Rivières	3	United States, Industry	1
Université du Québec à Montréal	30	École Polytechnique de Montréal	6
Université du Québec à Chicoutimi	1	École de technologie supérieure	1
Université de Sherbrooke	11	Canada, gov. org.	2
Université de Montréal	48	Other, Mexico	2
Concordia University	28	Other, Europe	15
Québec, Industry	3	Other, United States	4
		Canada (outside Québec)	11

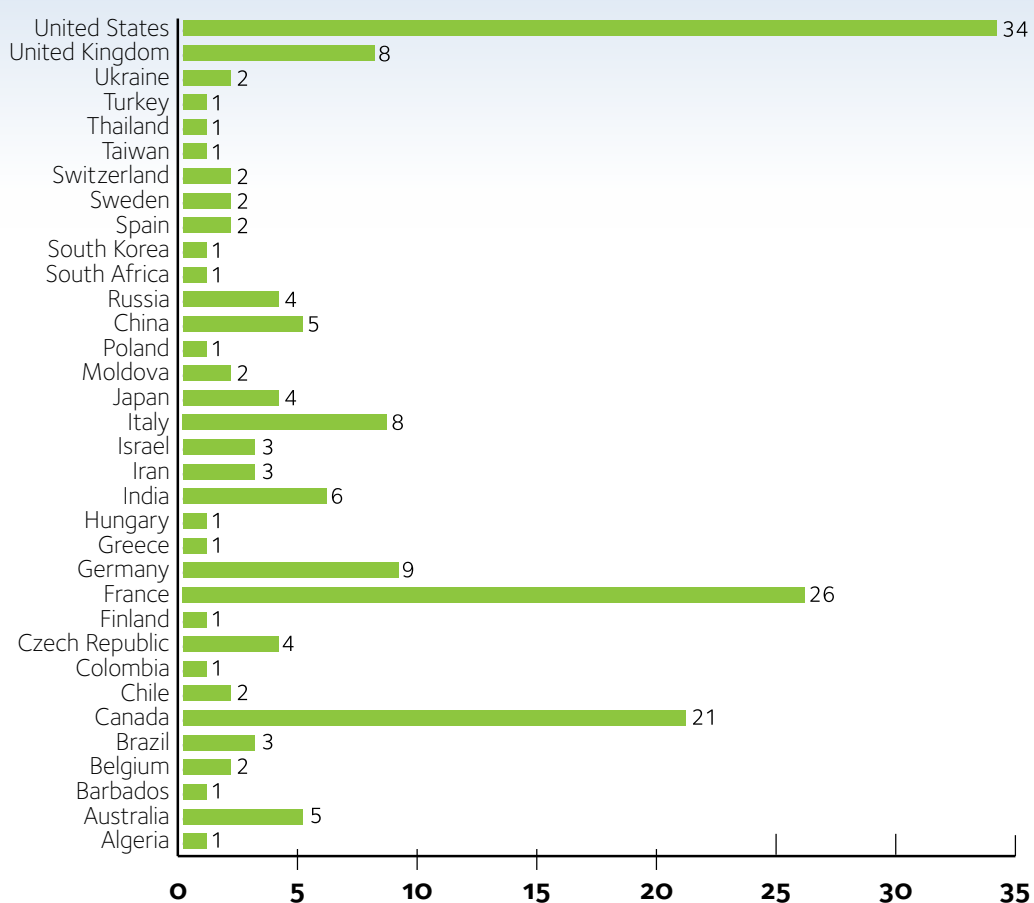
RESEARCHERS TAKING PART IN CRM ACTIVITIES, BY COUNTRY



United States	480	Japan	28
United Kingdom		Italy	25
Switzerland	14	Israel	19
Spain	11	India	9
South Korea		Germany	62
China	9	France	117
Poland	14	Canada	784
Other, Europe	41	Brazil	9
Other, Asia	7	Belgium	17
Other, Americas	16	Australia	11
Mexico	8	Africa	11

THE CRM IN NUMBERS (CONTINUED)

VISITING RESEARCHERS (INCLUDING POSTDOCTORAL FELLOWS), BY COUNTRY



CRM ADMINISTRATIVE AND SUPPORT STAFF

THE DIRECTOR'S OFFICE

LUC VINET	Université de Montréal, mathematical physics Director
GALIA DAFNI	Concordia University, harmonic analysis Deputy Director – Publications
ODILE MARCOTTE	UQAM and GERAD, combinatorial optimization Deputy Director – Partnerships
IOSIF POLTEROVICH	Université de Montréal, geometric spectral theory Deputy Director – Scientific Programs

ADMINISTRATION

VINCENT MASCIOTRA	Head of Administration
LUCIE VINCENT	Secretary
GUILLERMO MARTINEZ-ZALCE	Research Laboratories Administrative Coordinator
DIANE BRULÉ-DE FILIPPIS	Administrative Assistant
WENDY BARRIENTOS	Administrative Assistant

SCIENTIFIC ACTIVITIES

LOUIS PELLETIER	Coordinator
LOUISE LETENDRE	Administrative Assistant
SAKINA BENHIMA	Project Manager

COMPUTER SERVICES

DANIEL OUIMET	Systems Administrator
ANDRÉ MONTPETIT	Office Systems Manager (half-time)

PUBLICATIONS

ANDRÉ MONTPETIT	Tex expert (half-time)
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COMMUNICATIONS

SUZETTE PARADIS	Communications Officer and Webmaster
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SPECIAL PROJECTS

STÉPHANE ROUILLON	Partnerships Development Officer
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CENTRE
DE RECHERCHES
MATHÉMATIQUES

End

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