CENTRE DE RECHERCHES MATHÉMATIQUES

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Geometric Analysis and Spectral Theory
Aisenstadt Chairs

The Aisenstadt Chair allows us to welcome in each of the thematic programs, two or three world-famous mathematicians for a one-week to a one-semester stay. The recipients of the chair give a series of conferences on set subjects, chosen because of their relevance and impact, within the thematic program, the first of which, in compliance to the donor André Aisenstadt's wish, must be accessible to a large public.

Scientific activities related to the semester "Geometric Analysis and Spectral Theory" included three Aisenstadt lecture series, by R. Schoen, L. Erdős and E. Lindenstrauss, described below.

Elon Lindenstrauss

Elon Lindenstrauss

Professor Elon Lindenstrauss from Hebrew University of Jerusalem delivered a series of three Aisenstadt lectures from June 4 to June 7, 2012 during the Workshop on Geometry of Eigenvalues and Eigenfunctions. Professor Lindenstrauss is a world leader in Ergodic Theory and Dynamical Systems. His contributions include the proof of Arithmetic Quantum Unique Ergodicity conjecture of Rudnick and Sarnak, work on Littlewood conjecture and study of distributions of periodic torus orbits in some arithmetic spaces. In 2010, he was awarded the Fields Medal. Professor Lindenstrauss has received numerous other prizes, including the Clay Fellowship, the 2003 Salem Prize, the 2004 European Mathematical Society Prize, the 2008 Michael Bruno Memorial Award, and the 2009 Erdős and Fermat Prizes.

In the lectures, Professor Lindenstrauss discussed his proof of Quantum Unique Ergodicity conjecture and related work, which concerns asymptotic distribution of eigenfunctions of the Laplacian on a Riemannian manifold in the semiclassical limit. Asymptotic behaviour of eigenfunctions is one example of the relationship between classical dynamics of systems and their quantum behaviour. The Quantum Unique Ergodicity Conjecture of Rudnick and Sarnak states that if the manifold has negative sectional curvature (which implies that the classical dynamics is uniformly hyperbolic, hence "chaotic," the eigenfunctions of the Laplacian should become equidistributed in the semiclassical limit.

In the first lecture titled "Entropy and Quantum Unique Ergodicity," Professor Lindenstrauss gave an overview of ergodic flows, Kolmogorov – Sinai entropy of ergodic measures, Ledrappier – Young entropy formula, and Bowen – Margulis theorem on equidistribution of periodic orbits. He then reviewed Shnirelman's Quantum Ergodicity theorem, Quantum Unique Ergodicity conjecture, and discussed recent results due to Anantharaman, Nonnenmacher and Koch that hold for general negatively curved surfaces.

The second and third lectures were devoted to Quantum Unique Ergodicity on finite area arithmetic hyperbolic surfaces. Such surfaces possess a lot of symmetry, provided by the Hecke operators. Joint eigenfunctions of the Laplacian and those operators are called Hecke – Maass automorphic forms. They play an important role in modern analytic number theory. One can use Hecke operators to get much more information about Hecke – Maass forms than about general eigenfunctions. Lindenstrauss surveyed recent results about these eigenfunctions (and the closely related class of holomorphic forms) using both number theoretic and dynamical techniques developed by himself (some of them together with Bourgain), Silberman and Venkatesh, Holowinsky and Soundararajan.

Professor Lindenstrauss also presented his recent joint work with S. Brooks which relates the study of eigenfunctions and quasi modes on arithmetic surfaces to the study of eigenfunctions of the discrete Laplacian on finite graphs.

Richard Schoen

Professor Richard Schoen delivered a series of three Aisenstadt lectures from February 27 to March 2, 2012. Professor Schoen is Anne T. and Robert M. Bass Professor of Mathematics at Stanford University. He is a world leader in the field of geometric analysis. His many outstanding research achievements include the proof of the positive mass conjecture in General Relativity (with Shing-Tung Yau), the solution of the Yamabe problem and the proof of the differentiable sphere theorem (with Simon Brendle). He has been awarded the Bôcher Memorial Prize, the MacArthur Fellowship and the

Guggenheim Fellowship. He is a member of the National Academy of Sciences and the American Academy of Arts and Sciences.

The three lectures by Professor Schoen focussed on some recent developments in geometric analysis. His first lecture was on "The geometry of positive curvature." He started with a beautiful survey of Riemannian manifolds of positive curvature, summarizing what is known and what is conjecturally true. He then presented the recent breakthrough on the quarter pinching theorem, which was proved by S. Brendle and himself. This landmark result was achieved through a powerful analysis of the Ricci flow, one of the most important techniques in geometric analysis, together with geodesic and minimal surface techniques. This result provides deep insight into the geometry of manifolds with positive curvature and represents another major advance in mathematics after Perelman's proof of the Poincaré conjecture.

In the second lecture, Professor Schoen described his recent work with A. Fraser concerning an extremal problem for the first Steklov eigenvalue on surfaces with boundary. This question is closely related to the investigation of extremal metrics for the first eigenvalue of the Laplacian on compact closed surfaces. In both Laplace and Steklov cases, extremal eigenvalue problems are linked to the study of minimal surfaces. For closed surfaces these are minimal surfaces in spheres, while for surfaces with boundary one obtains minimal surfaces in a ball satisfying some natural boundary condition. A detailed description was given for extremal surfaces for the first Steklov eigenvalue in the genus zero case.

Richard Schoen

The final lecture was concerned with a new mean curvature proof of the space-time positive mass theorem. The original Schoen – Yau mean curvature proof of the general positive mass theorem gave the positivity of energy. In a recent joint work with M. Eichmair, L. Huang, D. Lee, a direct proof was given of the timelike character of the total energy momentum vector using the marginally outer trapped surface (MOTS) equation. They also improved the density theorems for initial data sets satisfying the dominant energy condition.

László Erdős

In the week of March 19, Professor László Erdős was visiting the CRM as Aisenstadt chair. László is Chair of Applied Mathematics and Numerics at the Ludwig-Maximilians-Universität München, Germany. He has made substantial contributions to the analysis of large quantum systems, in particular concerning the derivation of effective kinetic equations in certain scaling limits. His recent research has led to spectacular new results in the theory of random matrices, which was the topic of his Aisenstadt lectures.

László Erdős

László gave three lectures during his visit. The first one, which was suitable for a general audience, was entitled "Universality of spectral statistics of random matrices." It contained a description of the recent proof of the celebrated Wigner – Gaudin – Mehta – Dyson conjecture, which was obtained by László in collaboration with Benjamin Schlein, Horng-Tzer Yau and Jun Yin. This conjecture asserts that the local eigenvalue statistics of a random matrix with independent entries depends only on the symmetry class of the random matrix and is independent of the detailed structure of the matrix ensemble. In particular, it is the same as for the Gaussian ensembles, where the eigenvalue distribution can be calculated explicitly. László presented a nice overview of the history of this subject, and explained the key steps involved in their proof.

His subsequent talk "The local version of Wigner's semicircle law and Dyson's Brownian motion" contained some of the details of the proof. In particular, László explained the notion of Dyson Brownian motion and how it can be used in combination with a local version of Wigner's semicircle law to prove universality for arbitrary Wigner matrices. Finally, in László's third talk "Quantum diffusion and random band matrices" the problem of localization vs. diffusion for random band matrices was discussed. Random band matrices can be viewed as intermediate between completely random matrices and random Schrödinger operators, where the randomness is only in the diagonal. There is a precise conjecture on the critical band width separating the regimes of localization and delocalization, respectively, and László and collaborators have recently made substantial progress towards a proof of this conjecture.

Mathématiques de la planète Terre 2013 (MPT 2013)

Le CRM est à l'origine de MPT 2013. *Christiane Rousseau, professeur au département de mathématiques et de statistique de l'Université de Montréal et chercheur au CRM en a été l'instigatrice lorsqu'elle dirigeait le CRM en* 2008-2009. *Elle en est maintenant la coordonnatrice au niveau international. Notons qu'elle est vice-présidente de l'Union mathématique internationale. L'initiative MPT* 2013 *est souvent décrite comme une année internationale* ; *en plus du patronage de l'UNESCO, elle a le soutien de l'Union mathématique internationale* (*UMI*), *de la Commission internationale de l'enseignement mathématique* (*CIEM*) *et du International Council of Industrial and Applied Mathematics* (*ICIAM*).

Les activités du programme ciblent différents groupes ; certaines s'adressent à un large auditoire, d'autres visent les enseignants et certaines s'adressent plus particulièrement aux chercheurs.

Voici une liste des activités que se tiendront à Montréal et au Québec.

Activités pour le public

• Table ronde lors du lancement canadien de MPT 2013 le 7 décembre 2012 de 12h30 à 13h45 sur le thème : « Que peuvent faire les mathématiques pour la planète ? » à l'Université de Montréal. Animateur : Pierre Chastenay ; panélistes : Michel Béland (Environnement Canada), Ivar Ekeland (Paris-Dauphine & UBC), Claude Hilaire-Marcel (UQÀM), Normand Mousseau (Université de Montréal), Marie-France Raynault (Université de Montréal). La table ronde est organisée conjointement par le Centre de recherches mathématiques (CRM), le Réseau de calcul et de modélisation mathématique (rcm_2), et la Société mathématique du Canada (SMC).

• Conférence publique par Ivar Ekeland (Paris-Dauphine & UBC) lors du lancement canadien de MPT 2013 le 7 décembre 2012 à 19h30 à l'hôtel Fairmont Le Reine Elizabeth : « Une longue histoire : la planète Terre et les mathématiques ».

• Conférence publique par Doyne Farmer (Oxford) lors du lancement canadien de MPT 2013 le 8 décembre 2012 à 19h à l'l'hôtel Fairmont Le Reine Elizabeth : « The complex challenge of sustainability ».

• Conférence publique organisée par la Société mathématique du Canada et le Centre de recherches mathématiques par Nilima Nigam (Simon Fraser), « The Mathematics of Light and Sound » à Montréal le 15 février 2013.

• Grande conférence du CRM à 19h30 dans le cadre des 24 heures de science le vendredi 10 mai 2013 par Paul Embrechts (ETH Zürich), « Les ponts de Königsberg, les digues de Hollande et la chute de Wall Street ». La conférence sera précédée d'animations mathématiques.

• Grande conférence du CRM à 19h30 le mercredi 25 septembre 2013 par Florin Diacu (Victoria), « La prévision des grandes catastrophes ».

• Conférence publique organisée par la Société mathématique du Canada et le Centre de recherches mathématiques par Christiane Rousseau (Université de Montréal), « Les mathématiques de la planète Terre » à Québec le 7 novembre 2013.

Activités pour les enseignants

• Une journée de conférences sur le thème MPT pour les professeurs de cégep lors du lancement canadien le 8 décembre (`http://smc.math.ca/Reunions/hiver12/cegeps`)

• Préparation d'un numéro spécial de la revue Accromαth (`www.accromath.ca`, cette revue est destinée aux écoles secondaires et cégeps.) ce numéro spécial sera distribué en Afrique avec l'aide de l'UNESCO.

(*suite à la page* 11)

2012 Spring Semester on Geometric Analysis and Spectral Theory

The 2012 Spring Semester on Geometric Analysis and Spectral Theory at the CRM brought together researchers working in these fields interpreted in a broad sense, as to include applications to fundamental problems in geometry, PDE, dynamical systems and mathematical physics. The semester was organized by G. Dafni (Concordia), P. Guan (McGill), D. Jakobson (McGill), V. Jakšić (McGill), N. Kamran (McGill), S. Klevtsov (Brussels), S. Kuksin (École Polytechnique), I. Polterovich (Montréal), S. Preston (Boulder, Colorado), R. Seiringer (McGill), A. Shnirelman (Concordia), A. Stancu (Concordia), J. Toth (McGill) and S. Zelditch (Northwestern).

Scientific activities related to the semester included six workshops described below.

Workshop on Convexity and Asymptotic Geometric Analysis

The workshop was held at CRM on April 16 – 20, 2012. It was organized by M. Ludwig (NYU-Poly, TU Wien), V. Milman (Tel Aviv) and A. Stancu (Concordia). It was characterized by a variety of talks as diverse as the field itself, a result of the rapid developments seen in the area in recent years. Moreover, almost a third of the speakers were very young researchers: graduate students or postdocs in within 3 years of their thesis completion, giving a measure of renewed interest and intense current activity in new and classical challenges of the field.

One of the directions emphasized in this meeting was the complexity of duality. The classical duality for convex bodies reflects in the space of convex functions in two other types of dualities whose properties are just being understood. New results were the subject of talks by Liran Rotem and Alexander Segal. One should note that duality of convex bodies is also at the core of Mahler's conjecture, an old outstanding problem in the field, on which progress was reported by Artem Zvavitch and Grigoris Paouris, each in a different context.

Area measures and their connection to PDEs, affine differential geometry and Hermitian integral geometry was touched upon by Mohammad Najafi Ivaki and, respectively, Thomas Wannerer. Further connections to quantum information theory (Elisabeth Werner), containment problems (Dan Klain) and geometric, isoperimetric-type, inequalities (David Alonso-Gutierrez) were also presented.

Another direction of research emphasized at the meeting was probabilistic in nature. One of the 2011 E. W. R Steacie Memorial Fellowship's recipients, Alexander Litvak, delivered a lecture on estimates on norms of random matrices with applications in convex geometry, computational geometry and compressive sensing theory. Different other probabilistic aspects were addressed by Carsten Schutt and Peter Pivovarov. The latter presented novel distributional inequalities for the volume of random convex sets.

Finally, in an exciting direction, the theory of valuation opens now a new road to algebraic integral geometry (Andreas Bernig), while classical problems of extending continuously valuations from subspaces of convex compact sets to the whole space are seeing solutions (Semyon Alesker).

Overall, the atmosphere was very enthusiastic, filled with discussions, and many of the talks were attended by local people outside the field. The CRM support, prior and during the meeting, was outstanding. The special CRM – ISM colloquium of the two-time ICM speaker, Vitali Milman, was integrated in the workshop's program and added to the visibility of the meeting.

Workshop on Geometric PDE

The workshop was held at CRM on April 23 – 27, 2012. It was organized by P. Guan (McGill), N. Kamran (McGill) and A. Stancu (Concordia). The goal of this workshop was to bring together researchers working in geometry and PDEs, with the objective of reviewing important recent results in the field and highlighting new research trends. The lectures were anchored around several subthemes of current interest:

- *Geometric flows in Riemannian and Hermitian geometry*: These topics were covered in the lectures by Ben Weinkove, Natasa Sesum, Junfang Li, McKenzie Wang, Tom Illmanen and Maria Buzano. The increasingly important role played by torsion in non-Kähler Hermitian geometry and the emergence of the Chern – Ricci flow as a new model for flows on complex surfaces, the recent advances in the study of singularity formation for the mean curvature flow of surfaces using new ideas from geometric measure theory, ancient solutions to the Yamabe flow and the explicit construction of Ricci flows on manifolds with large isometry groups were highlighted throughout these lectures.
- *Extremal Kähler and other special metrics*: These formed the substance of the lectures by Vesti Apostolov, Jixiang Fu, Valentino Tosatti, Ailana Fraser and Spiro Karigiannis. Recent developments on the explicit construction of extremal Kähler metrics on toric orbifolds, Hermitian Yang – Mills metrics on stable vector bundles, collapsing of Calabi – Yau manifolds, extremal eigenvalue problems for surfaces with boundary, and G_2 structures were at the heart if this set of lectures.
- *PDE problems in connection with the Monge – Ampère equation, the Yamabe problem and General Relativity*: These were dealt with in the lectures by Bo Guan, Joel Spruck, Steve Zelditch, Mu Tao Wang, Lei Ni, Marcus Khuri, Ahmed Zeriahi and Gantumur Tsogtgerel. Many important advances and new perspectives were covered in the lectures. Again, torsion in Hermitian geometry occupied a prominent place in the talks concerned with the Monge – Ampère equation, as well as the analysis of the initial value problem in connection to the geodesic equation on the set of Kähler metrics. From the General

Relativity perspective, the central role was played by the initial value problem with various geometric assumptions on the initial data sets, as well as the important problem of defining of quasi-local mass and momentum for isolated systems.

The workshop was very successful in bringing together some of the strongest researchers active today in geometric analysis. Many fruitful scientific discussions and exchanges took place during the workshop, during and between the lectures, making this a memorable scientific event.

Workshop on Geometry and Dynamics of Fluid

The workshop was held at CRM on May 21 – 25, 2012. It was organized by S. Kuksin (École Polytechnique), S. Preston (Colorado Boulder) and A. Shnirelman (Concordia). The workshop consisted of 25 speakers, who each gave 40-minute talks on various topics related to fluid mechanics. The goal of the workshop was to get experts in disparate areas of fluid mechanics interested in each others' work, and our compressed format of short talks made it easy for people to attend many of them.

The topics our speakers focused on broadly included (i) long-time behaviour of two-dimensional fluids, (ii) aspects of the diffeomorphism group geometry, (iii) one- and two-dimensional model systems for fluids, (iv) aspects of turbulence in three-dimensional fluids, and (v) weak solutions of the Euler equations.

(i) Emanuele Caglioti and Clément Mouhot spoke on various aspects of the long-time behaviour of solutions of the 2D Euler equation. Although global existence for sufficiently smooth solutions of 2D Euler has been known for many years, there are still poorly understood phenomena such as the seeming existence of attractors and the energy cascade. Caglioti explained aspects of attractors in a weak-damping limit, and Mouhot described a rigorous approach to Landau damping.

(ii) David Ebin, Francois Gay-Balmaz, Feride Tiglay, Cornelia Vizman, and Vladimir Zeitlin spoke on global differential geometric aspects of the Euler and related equations, which follow the Arnold approach to fluid mechanics via Riemannian geometry of the diffeomorphism group. Ebin described the geometry of quantomorphism groups, Gay-Balmaz spoke on liquid crystal equations, Tiglay spoke about geometric aspects of some integrable 1D equations, Vizman described dual pair structures for generalized Camassa – Holm equations, and Zeitlin discussed finite-dimensional Lie algebra structures to approximate fluid and geostrophic equations.

(iii) Diego Cordoba, Walter Craig, Susan Friedlander, Boris Khesin, Filippo Santambrogio, Vlad Vicol, and Xinwei Yu all spoke about various one- and two-dimensional PDEs which share structures with the 3D Euler or Navier – Stokes equations. Friedlander and Vicol spoke about different aspects of active-scalar equations such as the surface-quasi-geostrophic equation. Yu spoke about some generalizations of the two-dimensional magnetohydrodynamic equations. Craig and Khesin spoke about vortex filament and vortex membrane equations, which model fluids for which vorticity is concentrated on singular sets. Cordoba spoke on free-boundary problems describing interfaces between two ideal irrotational fluids. Santambrogio described a crowd-flow model which relates to optimal transport and generalized flows of fluid.

(iv) Alexey Cheskidov, John D. Gibbon, Roman Shvydkoy, and Vladimir Sverak spoke about aspects of turbulence and blowup in the 3D Euler and Navier – Stokes equations. Cheskidov and Gibbon addressed intermittency in the Navier – Stokes equations (i.e., large deviations from the mean in vorticity) and its possible relation to blowup. Shvydkoy discussed nonexistence of self-similar blowup solutions of the Euler equation, while Sverak discussed self-similar solutions of the Navier – Stokes equation.

(v) Finally, Anna Mazzucato, Gerard Misiolek, and Sergey Denisov spoke on aspects of weak solutions of Euler and Navier – Stokes equations. Mazzucato described results on the dissipation of enstrophy in weak solutions of the 2D Euler equation with unbounded vorticity. Misiolek described the failure of well-posedness in the Hadamard sense for 2D Euler, constructing examples for which the dependence on initial conditions is continuous but not uniformly continuous. Denisov gave sharp results on the dynamics of vortex patches which collapse into each other asymptotically, as well as estimates on the growth of Sobolev norms for smooth 2D Euler solutions.

The workshop featured a lively mix of talks together with some social events such as a reception, a walking tour of the Old City, and a free banquet in order to foster discussion and collaboration. Diversity of speakers (by age, gender, location, and field) was a primary goal of the organizers. Graduate students were actively supported and encouraged to attend all events. Attendees expressed great appreciation for the organization and the facilities of the CRM, and we believe we fostered several useful collaborations in the future.

Workshop on Quantum Many-Body Systems

The workshop took place at the CRM from May 28 to June 1, 2012. It was organized by V. Jakšić (McGill) and R. Seiringer (McGill). It consisted of 20 one-hour lectures by the participating experts in this field. The unifying theme of the workshop was the mathematical analysis of models in quantum mechanics describing a large number of mutually interacting particles. The topics covered concerned the renormalization group analysis of lattice models in condensed matter physics, including graphene, the interaction of matter with radiation, effects of impurities (i.e., randomness) on interacting particle systems, semiclassical analysis of atoms and molecules, and the characterization of possible phases occurring in ground states in low-dimensional spin systems.

Four lectures were scheduled each day of the week, two in the morning and two in the afternoon. This schedule left plenty of time for discussions among the participants before and after the lectures. These discussion have led to new ideas, interesting open problems and new research directions that will be pursued in the future. The excellent facilities and pleasant atmosphere at the CRM have contributed to the success of the workshop, and many participants have expressed

their interest in returning to the CRM in the near future for similar events.

The workshop started on Monday with a talk by Elliott Lieb, in which he explained entanglement in quantum systems and ways to quantify it using entropy inequalities. The second morning talk by Heinz Siedentop concerned a model of a graphene quantum dot, for which spectral properties were investigated. Graphene was also the topic of the first afternoon talk by Vieri Mastropietro, who presented a proof of universal conductivity using rigorous renormalization group techniques. The final talk on Monday was given by Alessandro Giuliani, and discussed the scaling limit of correlation functions in nonintegrable Ising models.

Mathieu Lewin gave the first talk on Tuesday, in which he explained how to obtain the Pekar model for a polaron as a macroscopic limit of a microscopic polaron model. The Scott correction in different models of atoms and molecules was the topic of the second talk, given by Jan Philip Solovej. Rupert Frank's talk in the afternoon concerned ground state properties of multipolaron systems, in particular the question of stability and binding. The last talk on Tuesday was given by Michael Sigal, in which he discussed Rayleigh scattering and the propagation speed of photons in phonons in simple quantum field models.

The effects of randomness on quantum systems were the topic of the first three talks on Wednesday. The session started with a talk by Michael Aizenman on phase transitions in quantum and classical spin systems subject to random external fields. It was followed by Simone Warzel's talk on the Bose – Hubbard model. Jakob Yngvason gave the first talk in the afternoon, explaining the effects of random impurities on one-dimensional Bose – Einstein condensates, described by the Lieb – Liniger model. The second afternoon talk was given by Victor Ivrii, explaining the asymptotics of the ground state energy for heavy atoms and molecules.

In the first talk on Thursday, Bruno Nachtergaele explained the classification of ground state phases in gapped one-dimensional quantum systems. The second talk by Robert Sims contained results on dynamical localization for the random XY spin chain. Israel Klich gave the first afternoon talk on Thursday, explaining entanglement in systems of matter coupled to radiation. Finally, Valentin Zagrebnov closed the session with a talk on his results on a model of a leaky photon cavity pumped by an atomic beam.

Friday was the last day of the workshop, and it started with a talk by Jan Derezinski on the joint energy-momentum spectrum of homogeneous Fermi gases. The second talk by Daniel Ueltschi investigated the nature of correlations in quantum Heisenberg models. Luttinger-type models of correlated fermions in higher dimensions were the topic of the first afternoon talk, given by Edwin Langmann. The final talk of the workshop was given by Christian Hainzl, explaining the microscopic derivation of of the Ginzburg – Landau model from the microscopic Bardeen – Cooper – Schrieffer theory.

Workshop on Geometry of Eigenvalues and Eigenfunctions

The workshop held at the CRM on June 4 – 8, 2012. It was organized by D. Jakobson (McGill) and I. Polterovich (Montréal). The workshop brought together the leading researchers and young mathematicians working in various areas of geometric spectral theory. Many problems in the field are motivated by questions originating in the study of real life phenomena: quantum-mechanical effects, vibration of membranes and plates, oscillations of fluids, etc. The conference continued a series of related meetings at the CRM, including workshops on Spectrum and Dynamics and Mathematical aspects of Quantum Chaos in 2008, as well as workshops on Spectral Geometry, Semiclassical Theory of Eigenfunctions and PDEs (CRM/Fields), and Spectral Theory and Automorphic Forms in 2004.

One of the main highlights of the meeting was a series of Aisenstadt lectures on quantum unique ergodicity by Elon Lindenstrauss. Quantum ergodicity and properties of eigenfunctions in the semiclassical limit were among the central themes of the workshop. Related topics were discussed in the talks by Suresh Eswarathasan, Hans Christianson, Shimon Brooks, Yiannis Petridis and Yaiza Canzani. A survey talk by Victor Ivrii focussed on the asymptotic distribution of eigenvalues and remainder estimates in Weyl's law. Dan Mangoubi presented a new proof, not involving "hard analysis," of the celebrated Donnelly – Fefferman estimate on the growth of high-energy eigenfunctions. In the talk on symbolic calculus of Fourier integral operators, Yuri Safarov developed an analytic machine that could be used to study quantum ergodicity for branching billiards.

The talks by Alexandre Girouard, Vladimir Kozlov, Alexei Penskoi, Eveline Legendre and Christopher Judge were concerned with the properties of eigenvalues of the Laplacian and other elliptic operators on Riemannian manifolds and Euclidean domains. Many important subjects were discussed, including extremal problems for eigenvalues on surfaces, estimates on the eigenvalues of Dirichlet-to-Neumann operators, domain dependence of Dirichlet eigenvalues, Kähler metrics with simple Laplace spectrum and existence of embedded eigenvalues in the continuous spectrum for hyperbolic triangles. Almut Burchard presented some recent results on Steiner symmetrization of compact sets. Steiner symmetrization is a powerful technique in geometric analysis that is used, in particular, to prove sharp isoperimetric inequalities for eigenvalues.

Several talks, including the ones by Rafael Benguria, Peter Perry and Achim Kempf, emphasized the links between spectral theory and mathematical physics. The talks by Ram Band and Grigori Rozenblioum focussed on the properties of eigenvalues and eigenfunctions of the Laplace and Schrödinger operators on combinatorial and quantum graphs.

Recent advances in computational spectral theory were presented by Alex Strohmaier and Alex Barnett. In particular, a new efficient method for numerical computation of Dirichlet eigenvalues of planar domains was presented, as well as a fast algorithm for calculating eigenvalues and spectral zeta functions on Riemannian surfaces with explicitly controlled error estimates.

The workshop also featured a stimulating session on open problems. A number of interesting questions were proposed by Victor Ivrii, Rafael Benguria, Alexandre Girouard and Dmitry Jakobson.

Workshop on Manifolds of Metrics and Probabilistic Methods in Geometry and Analysis

The workshop was held at CRM on July 2 – 6, 2012. It was organized by D. Jakobson (McGill), S. Klevtsov (ULB) and S. Zelditch (Norhtwestern). The workshop brought together mathematicians and physicists working on questions related to random geometry in a broad sense. The organizers hope that this conference will spur rapid development in the new area of rigorous approaches to random metrics, inspired by the physics research during last 30 years in this subject.

Morning sessions during the first two days of the workshop were devoted to lectures on 2d quantum gravity and the physical definition of random metrics. Frank Ferrari started on Monday with the introduction to the seminal 1981 work of Polyakov on Liouville 2d gravity. Further developments in Liouville gravity during the 80's and 90's were reviewed in two lectures by Francois David on Monday and Tuesday. Finally, Bertrand Duplantier gave an introductory lecture on his ground-breaking 2008 work with Scott Sheffild where random two-dimensional volume form was mathematically rigorously defined and KPZ relations were proved using the DDK's GFF approach.

Monday afternoon talks were devoted to the geometry of the space of Riemannian metrics. Brian Clarke introduced the L^2 (or Ebin) distance on the space of Riemannian metrics, discussed the construction of its completion, and showed that the resulting metric space has nonpositive curvature. Sun surveyed the work on the metric geometry of the space of Kähler metrics, and its importance in the study of canonical metrics in Kähler geometry, in particular of constant scalar curvature metrics. Yanir Rubinstein gave a survey on different aspects (PDEs, Hamiltonian dynamics, geometric flows, convex geometry, geometric quantization, metric geometry) of the geometry of the infinite-dimensional space of Kähler metrics.

Bertrand Duplantier started his morning talk on Wednesday July 4th, by congratulating the audience with the discovery of the Higgs particle, announced on that day. After that F. David talked on a new (physical) derivation of the KPZ relation using replica trick. Liam McAllister reviewed recent advances in the problem of counting metastable vacua in string theory landscape, due to creative application of random matrix model methods. Wednesday's afternoon session was devoted to novel approaches to random metrics. S. Klevtsov talked on a novel definition of random metric on a Kähler manifold, which arises as the scaling limit of random matrix ensembles of Bergman metrics and its relation to stability in Kähler geometry. In Robert Berman's talk Kähler – Einstein metrics "emerge" in the large N limit of certain random point processes, giving rise to a new notion of stability. Physical applications of Aubin – Yau and Mabuchi action functionals in Kähler geometry, possibly leading to the extentions of the Polyakov's Liouville model of quantum gravity, were explained by Frank Ferrari on Friday. Tuesday talk by Scott Sheffield described Imaginary Liouville quantum gravity and its implications.

A possible extension of results of Duplantier and Sheffield in dimension two to higher dimensions was outlined on Friday. Raphael Ponge gave an overview of Fefferman's program, conformally invariant differential operators (including the Yamabe and the Paneitz operators). He also presented a computation of the logarithmic singularities of the Green functions of the conformal powers of the Laplacian. Linan Chen outlined a construction of random measures in dimension four (inspired by the construction of Duplantier and Sheffield in dimension two), and described an approach to derive a KPZ-type relation for spherical averages of those measures.

Several talks at the conference were devoted to the properties of random functions, random sections of holomorphic line bundles, and related problems. On Tuesday, Bernard Shiffman discussed critical points of random sections of holomorphic line bundles. Boris Khanin discussed his recent results on correlations and nearest neighbour spacings between zeros and critical points of random polynomials. Nikolai Makarov discussed distribution of eigenvalues for random normal matrix ensembles, near the boundary and near some singular points in the bulk.

On Thursday, Robert Adler discussed some results in random algebraic topology, including the persistence homology of the sublevel sets of Gaussian processes over manifolds, and limit theorems for the Betti numbers of random complexes built over random point processes. Liviu Nicolaescu described his results on critical values of random functions on a given compact Riemann manifold, given as a random Fourier series involving the eigenfunction of the Laplacian. Igor Wigman described his results on nodal length fluctuations for random Gaussian Laplace eigenfunctions on the torus ("arithmetic random waves").

Nicolas Burq gave a talk on probabilistic Sobolev embeddings, showing that, from a PDE point of view, randomly chosen functions may behave much more nicely than what the deterministic theory would predict. On Friday, Yaiza Canzani described recent results on the distribution of perturbations of propagated Schrödinger eigenfunctions, establishing asymptotics for their moments under certain admissibility conditions (that involve geometry of the space of metrics on Riemannian manifolds).

Several talks at the conference were also devoted to the geometry of manifolds of metrics. In addition to the talks describing the geometry of spaces of Kähler metrics, and the talk of Brian Clarke on the L^2 distance, Lior Silberman described how the CAT(0) property of the manifold of Riemannian metrics can be used to show that random groups with strong fixed-point properties have no nontrivial smooth volume-preserving actions on compact manifolds, via the associated action on the space of metrics. Finally, Dmitry Jakobson described how one can define Gaussian measures on manifolds of metrics with the fixed volume form, and use them to compute the moment generating function for the Ebin distance to the reference metric.

Unité Mixte Internationale CNRS-CRM

de Laurent Habsieger, directeur de l'UMI CRM

Cela fait un an que l'UMI a été créée, pour structurer et accroître les collaborations entre mathématiciens français et québecois, selon les termes de la convention signée le 4 octobre 2011 (voir le *Bulletin du CRM* de l'automne 2011). L'UMI a immédiatement connu un succès indéniable, et a rendu possible de multiples collaborations, détaillées ci-dessous.

Avant cette présentation, rappelons les différentes formes que peuvent prendre les visites de collègues français. Pour des séjours de six mois ou un an, nos collègues français universitaires doivent obtenir une délégation au CNRS, qui paye alors leur salaire à leur université d'origine. De plus les chercheurs, universitaires ou du CNRS, dont le projet a été retenu, reçoivent une indemnité de mission mensuelle de l'INSMI, l'Institut chargé des mathématiques au CNRS. Ces coûts sont pris en charge directement par le CNRS, et ne sont pas comptabilisés dans le budget de l'UMI. Pour les séjours plus courts, c'est l'UMI qui paye directement sur ses fonds propres les frais de mission. Le CRM, qui héberge l'UMI, fournit un appui logistique pour les invités de longue durée.

La première délégation fut obtenue par Claude-Alain Pillet, professeur à Toulon, qui est venu à Montréal entre février et juin 2012. En décembre 2011, cinq collègues ont demandé une délégation pour l'année universitaire 2012-2013 : Carlo Gasbarri, professeur à Strasbourg, Erwan Rousseau, professeur à Marseille, Mattia Cafasso, maître de conférences à Angers, Émmanuel Fricain, maître de conférences à Lyon, Annalisa Panati, maître de conférences à Toulon. Tous ont obtenu une délégation et pourront donc venir collaborer avec les membres de l'UMI.

En sus des chercheurs universitaires, l'INSMI finance la venue de chercheurs CNRS. Ainsi Pierre Ille et Gérard Freixas Montplet viennent six mois à l'UMI en 2012. Sheila Sandon bénéficie quant à elle d'un cofinancement UMI/INSMI/François Lalonde pour passer l'année universitaire 2012-2013 à Montréal.

Sur ses fonds propres, l'UMI a financé plusieurs missions. Marie Albenque, chargée de recherche CNRS à Polytechnique, et Louigi Addario-Berry, professeur à McGill, ont ainsi pu collaborer pendant deux mois consécutifs, chacun des deux visitant l'autre pendant un mois. L'UMI a également pris en charge le voyage de Vincent Pilaud, chargé de recherche, et financera la venue de Robert Conte, professeur au CEA à Saclay. La dernière mission payée par l'UMI fut ma participation comme conférencier invité au colloque de combinatoire additive CAPARIS 2012.

L'UMI a également cofinancé deux Entretiens Jacques Cartier dédiés aux mathématiques : « Aventures en Physique Mathématique » et « Mathématiques appliquées à la gestion des risques ». Ces colloques se tiendront à la mi-novembre 212 à Lyon.

Tout début 2012, deux projets impliquant des membres de l'UMI ont été déposés à l'ANR (Agence Nationale pour la Recherche). Le projet CAESAR, que je pilote localement, a été retenu, ce qui constitue une excellente nouvelle pour l'UMI, dans la mesure où relativement peu de projets sont choisis (environ le tiers de l'ensemble des projets déposés). J'encourage les membres de l'UMI à soumissionner régulièrement, pour obtenir de nouveaux moyens conséquents.

En résumé la création de l'UMI a permis de développer de nombreuses interactions, sous de multiples formes. L'avenir s'annonce radieux pour l'UMI !

Appel à projets

Le Centre de recherches mathématiques (CRM) vous invite à proposer des projets d'activités scientifiques. Les activités scientifiques se divisent en deux catégories : les semestres thématiques d'une durée de six mois environ, et les conférences, ateliers ou écoles d'une durée de quelques jours à 2 semaines.

Ateliers, Écoles et Conférences

Les applications pour les ateliers, écoles ou conférences doivent être reçues par le CRM un an avant la date proposée pour la tenue de l'événement. Exceptionnellement, l'échéance d'un an peut être réduite à six mois. Les demandes doivent inclure :

- Une description détaillée de l'événement ;
- Une liste des principaux conférenciers ;
- Les dates proposées pour la tenue de l'événement ;
- La composition du comité organisateur.

Semestres thématiques

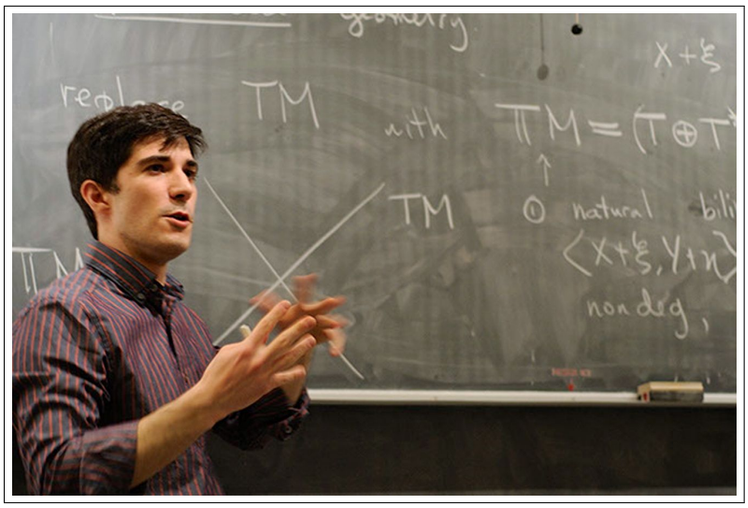
Les dates limites pour les propositions pour des semestres thématiques sont le 15 mars et le 15 septembre de chaque année. Les semestres thématiques ont lieu soit du 1er janvier au 31 juin (le semestre d'hiver), ou du 1er juillet au 31 décembre (le semestre d'automne). Les applications doivent être soumises au CRM au moins 18 mois avant la date du début du programme proposé. Les activités scientifiques des semestres thématiques incluent typiquement des ateliers, écoles et conférences ; des fonds sont aussi alloués pour les stagiaires postdoctoraux, les visiteurs à court et à long terme et deux chaires Aisenstadt. Toute proposition sera examinée par la direction du CRM et par le Comité scientifique international du CRM qui évalueront la qualité scientifique du projet : les fondements scientifiques, la pertinence du projet, les grandes conjectures et défis mathématiques, etc. Si le programme est accepté, les membres du comité organisateur seront en charge de l'organisation du programme thématique, en collaboration avec le directeur et le personnel du CRM qui accompagneront les organisateurs pas à pas dans l'organisation du semestre, incluant les demandes de financement externe. Le CRM héberge aussi dix laboratoires qui participent souvent à l'organisation et au financement des semestres thématiques.

Vous trouverez plus de détails à la page : `http://crm.math.ca/act/form/propositions_fr.shtml`

Tous les documents doivent être envoyés par courriel au directeur du CRM : `directeur@crm.umontreal.ca`.

2012 André-Aisenstadt Prize

Marco Gualtieri (University of Toronto) and Young-Heon Kim (UBC) were the 2012 André-Aisenstadt Prize recipients. This prize celebrates outstanding research achievement by a young Canadian mathematician. The research of Young-Heon Kim was described in the last bulletin.



Marco Gualtieri

Dr. Gualtieri obtained a bachelor degree in science at McGill University in 1999 and his Ph.D. from Oxford University in 2004 under the supervision of Nigel J. Hitchin. He was awarded the Lichnerowicz Prize in Poisson geometry in 2010 and he joined the University of Toronto in 2008. Prior to that, Professor Gualtieri held postdoctoral positions at MSRI, Berkeley, the Fields Institute in Toronto and MIT. His area of research is differential geometry and he made essential contributions to the development of generalized complex geometry, an active area of research at the interface of complex geometry and symplectic geometry.

More specifically, Marco Gualtieri's research focuses on the geometry of generalized complex structures, a fairly recent and active area of mathematics pioneered by Nigel Hitchin in the 2000s, which provides a novel and unified approach to symplectic and complex geometry. Applications to mathematical physics (string theory and mirror symmetry) and noncommutative geometry are at the forefront of current developments in this vibrant domain.

In this vein, Marco Gualtieri's Ph.D. thesis provides the first systematic study of generalized complex geometry, and introduces a number of new notions of fundamental importance, such as the Kuranishi theory for generalized complex structures and the generalized Kähler geometry. His foundational work has been the source of inspiration for many related studies. Currently, Google Scholar lists 535 citations to this work and one part of it has recently appeared in the *Annals of Mathematics*. More recently, Marco Gualtieri has studied D-branes in generalized complex manifolds and their relation to noncommutative geometry, as well as further generalizations of classical geometries. At the age of 32, he was awarded the prestigious André Lichnerowicz Prize (shared) at the IMPA in Rio de Janeiro and won an Early Research Award of the Ontario Government for the period 2010 – 2015.

Our sincere congratulations go to Professor Gualtieri for this well-deserved achievement!

Call to Proposals

The CRM (Centre de recherches mathématiques) is soliciting applications for scientific activities taking place at the CRM. The proposals are divided in two categories: the thematic semesters, of a duration of about six months, and the workshops, conferences or schools, whose duration can vary from a couple of days up to two weeks.

Workshops, Schools and Conferences

The proposal for workshops, schools or conferences must be received by the CRM at least one year before the date proposed for the event. In exceptional cases, this deadline can be reduced to six months. The proposals must include:

- A description of the event. The description must emphasize the goals, the background, and the timeliness of the event, as well as the formation activities for graduate students and postdoctoral fellows (approximately 3 – 5 pages);
- A tentative list the principal invited speakers;
- Some proposed dates for the event;
- The composition of the organizing committee, with the names, affiliations and curriculum vitae of the committee members.

Thematic Semesters

The deadlines for proposals for thematic semesters are March 15 and September 15 of each year. The thematic semesters take place from January 1 to June 31 (for the Winter Semester), and from July 1 to December 31 (for the Fall Semester). The applications must be submitted to the CRM at least 18 months before the beginning of the semester. The scientific activities of each semester typically include workshops, conferences and schools; some funds are also allocated to support postdoctoral fellows, short and long-term visitors and two Aisenstadt chairs. All propositions will be examined by the direction of the CRM and the International Scientific Advisory Committee which will evaluate the quality of each proposal: the scientific foundations, the pertinence and timeliness of the proposal, the main mathematical challenges and conjectures, etc. If the program is accepted, the members of the organising committee will be in charge of the organization of the thematic program, in collaboration with the director and the CRM personnel which will be present at every step of the organization of the semester, including for the applications for external funding. The CRM also include ten scientific laboratories which sometimes participate actively in the organization and financing of the thematic semesters.

You will find all the details at `http:://crm.math.ca/en/act/form/propositions_an.shtml`

All the documents must be sent to the CRM director by email at: `director@crm.umontreal.ca`.

2012 CAP – CRM Prize in Theoretical and Mathematical Physics

Luc Vinet (Université de Montréal)

The Canadian Association of Physicists (CAP) and the Centre de recherches mathématiques (CRM) are pleased to announce that the 2012 CAP – CRM Prize in Theoretical and Mathematical Physics is awarded to Luc Vinet, Université de Montréal, for his outstanding and continued contributions to mathematical physics, mainly based on the study of symmetries, algebraic structures, and special functions.

Luc Vinet

Luc Vinet is one of Canada's leading mathematical and theoretical physicists who has made outstanding contributions in numerous areas. The unifying feature of his research is the innovative use of group theoretical and algebraic methods, the emphasis on exact solutions of physical problems and the originality of his approach.

He has made important contributions that have had great impact on both physics and mathematics. His early remarkable work was on gauge field theories in particular on exact invariant solutions of Yang Mills equations in Minkowski space. Also early in his career he identified the symmetries and supersymmetries of magnetic monopole systems. He explored various algebraic structures appropriate to describe symmetries in different physical problems. These go well beyond standard Lie groups and algebras. They include polynomial, quantum, super- and para-super-algebras. He is very well known for his influential work on quantum many body problems and for his application of this work to a proof of the long outstanding Macdonald conjecture on properties of multivariate orthogonal polynomials. His contributions to the symmetry theory of difference and q-difference equations are truly pioneering.

Remarkably, Vinet's scientific career was not interrupted by his heavy administrative duties as director of the Centre de recherches mathématiques, then provost of McGill University and finally rector of the Université de Montréal. He continued to publish highly innovative work during his administrative tenure and is now going through a new burst of creativity. Quite recently, in 2011, he has discovered new families of orthogonal polynomials, associated to reflections. These have already found many applications. In the context of quantum information theory, he has shown how spin chains can be used to design perfect quantum wires.

The CAP – CRM Prize in Theoretical and Mathematical Physics is intended to recognize research excellence in the fields of theoretical and mathematical physics. This prize was first introduced in 1995 and has been awarded annually since.

Dr. Vinet gave a prize lecture entitled *Fils quantiques, polynômes orthogonaux et approximation diophantienne* at the CRM on October 5, 2012.

The Canadian Association of Physicists, founded in 1945, is a professional association representing over 1600 individual physicists and physics students in Canada, the U.S. and overseas, as well as a number of corporate, institutional, and departmental members. In addition to its learned activities, the CAP also undertakes a number of activities intended to encourage students to pursue a career in physics.

La réponse de Luc Vinet suite à l'obtention de la médaille 2012 de l'ACP et du CRM en physique théorique et mathématique

Occasions saisies : une expression de reconnaissance envers le CRM

Je suis enchanté et fort honoré de recevoir cette année la médaille ACP-CRM en physique théorique et mathématique. J'aimerais tout d'abord remercier les généreux collègues qui ont proposé et appuyé ma candidature. Tout au long de ma carrière, j'ai toujours eu cette chance de travailler avec des amis, et desquels j'ai beaucoup appris. À tous, collaborateurs, postdocs et étudiants, je veux exprimer ma très grande reconnaissance.

Il se trouve que j'ai joué un rôle dans la création de la médaille ACP-CRM en physique théorique et mathématique. J'ai reçu une partie de ma formation au Centre de recherches mathématiques (CRM) et j'ai ensuite eu le privilège d'en être le directeur de 1993 à 1999. Je me réjouis beaucoup de constater à quel point le CRM fait école, et d'observer qu'une communauté internationale grandissante et très interconnectée a des racines au CRM. En 1995, il a semblé pertinent de créer un prix pour célébrer la physique théorique et mathématique au Canada. L'ACP et le CRM ont alors lancé conjointement cette récompense qui a depuis été accordée à des chercheurs exceptionnels. C'est donc un insigne honneur d'être inclus dans ce groupe quand on sait qu'il y a beaucoup d'autres personnes remarquables qui le mériteraient aussi.

L'on comprendra que ce prix avec ses évocations diverses de ma carrière, revêt pour moi un caractère assez spécial et que « l'effet boomerang » est en l'occurrence grandement apprécié.

Si le mariage entre la physique et les mathématiques a une longue et fructueuse histoire, il a aussi ses ratés. À l'occasion de sa conférence Gibbs célèbre intitulée « Missed Opportunities » – « Occasions manquées » en français (Bulletin of the American Mathematical Society **78** *(septembre* 1972*), n°* 5*), Freeman Dyson a élaboré de manière éclairante sur des moments où mathématiciens et physiciens sont passés à côté de découvertes, faute de communications. Le titre que j'ai donné à cette réponse fait évidemment référence à cet article de Dyson ; je souhaiterais cependant faire brièvement mention de deux contre-exemples égocentriques où le CRM m'a fourni l'occasion des échanges dont Dyson déplorait le manqué de fréquence.*

La preuve (d'une partie) de la conjecture de Macdonald que Luc Lapointe (alors étudiant au Ph.D.) et moi avons construite est souvent soulignée en tant que réalisation d'intérêt. En 1995*, nous cherchions des solutions exactes du modèle à N corps de Calogero-Sutherland et nous avions obtenu des opérateurs de création pour les polynômes à plusieurs variables intervenant dans les fonctions d'onde. Il y avait un atelier en combinatoire algébrique qui se tenait au CRM pendant ce temps. Cela nous a donné l'occasion de présenter nos résultats à quelques uns des participants qui nous ont fort gentiment mis au fait de cette conjecture de Macdonald en suggérant que nous avions peut-être obtenu des outils qui pourraient permettre de la démontrer. Ils avaient raison bien sûr et il s'est agi d'une situation où la physique a engendré la solution d'un problème mathématique.*

À l'été 2010*, après une période de* 11 *ans consacrée à l'administration universitaire, j'avais entrepris mes premières recherches en information quantique en examinant le design de chaînes de spin susceptibles d'engendrer le transfert parfait d'états quantiques, et encore une fois, le CRM m'a été d'une aide précieuse en organisant (sans que j'y aie été pour quoi que ce soit) un semestre sur l'information quantique qui rassembla à Montréal plusieurs experts avec qui j'ai pu valider mes résultats.*

Même en ces temps où l'interdisciplinarité semble de mise, perçue en certains milieux comme étant mi-figue, mi-raisin, la physique mathématique peine parfois à trouver son droit de cité. La science de qualité ne devrait pas être affectée par les étiquettes, les modes ou les cliques. À la suite de Dyson, je souhaite qu'il y ait plus d'« occasions saisies » et je tiens à faire l'éloge de ces remarquables instituts à travers le Canada, qui comme le CRM font en sorte que ces occasions arrivent souvent en rassemblant judicieusement des scientifiques en provenance d'horizons divers.

Selon la formule de Wigner, l'exploration de la déraisonnable efficacité des mathématiques dans les sciences naturelles (Communications on Pure and Applied Mathematics **XIII** (1960), 1-14) *n'a de cesse d'émerveiller. Je suis privilégié de pouvoir m'y consacrer ; que cela m'amène un prix par surcroît, c'est vraiment du glaçage sur le gâteau ! Tous mes remerciements encore une fois à ma famille, à mes amis, à l'ACP et aux organisations qui m'offrent leur soutien.*

MPT 2013

(*suite de la page* 3)

Activités pour les enseignants

• Congrès 2013 de l'Association mathématique du Québec (AMQ) sur le thème MPT : ce congrès regroupe les enseignants du primaire, secondaire et collégial, ainsi que quelques universitaires et des didacticiens des mathématiques.

• Congrès 2013 du Groupe des Responsables en mathématiques au secondaire (GRMS) sur le thème MPT.

Activités scientifiques

• Lancement canadien lors du congrès de la Société mathématique du Canada : 7 au 10 décembre 2012 : le congrès inclut deux conférences plénières MPT, deux conférences publiques MPT et des sessions spéciales MPT.

• 2 ateliers du programme thématique pancanadien : « Modèles et méthodes en épidémiologie, écologie et santé publique »

• 1 atelier du programme thématique international : « Mécanique céleste », en juillet 2013.

• Un programme thématique au Centre de recherches mathématiques de juillet à décembre 2013 : « Biodiversité et évolution ».

• Colloques pour les chercheurs en sciences mathématiques sur le thème MPT, certains en partenariat avec les centres du Réseau de calcul et de modélisation mathématique (rcm_2) : CIRRELT, CIRANO, CRM et GERAD.

23rd International Meeting on Probabilistic, Combinatorial and Asymptotic Methods for the Analysis of Algorithms

The 23rd International Meeting on Probabilistic, Combinatorial and Asymptotic Methods for the Analysis of Algorithms (AofA 2012) was held in Montréal in June 2012. The organizers were Nicolas Broutin (INRIA) and Luc Devroye (McGill).

The conference consisted of 5 invited talks by distinguished researchers in the field of algorithms and combinatorial structures: Amin Coja-Oghlan (Warwick), Michael Drmota (TU Wien), Svante Janson (Uppsala), Claire Mathieu (Brown, CNRS, ENS), Avi Wigderson (IAS, Princeton); and and 32 presentations which had been selected by the program committee after submission of a 12-page abstract.

The meeting is part of a series of conferences and workshops that has been going on for more than two decades. It aims at providing a venue for the people working in the field of theoretical computer science or discrete mathematics in order to present the recent advances, exchange, and foster new contacts and collaborations about the asymptotic behaviour of random combinatorial structures and their applications to the analysis of algorithms and data structures. Participants have mixed backgrounds going from combinatorics, complex and asymptotic analysis to probability theory and stochastic processes.

It is remarkable that the meeting at CRM showed increasing signs that the community is blending: in particular, the different groups on which the meeting traditionally relies (analysts, combinatorists, probabilists) are now certainly more porous than they used to be. We were glad to see that the proportion of students and young researchers had not declined, in spite of the distance to Europe where most of the community lies.

This year's meeting was especially successful with talks covering a broad range of topics in algorithms or data structures, combinatorics, discrete probability, or methodology. All the talks were very lively and provided interesting new points of view on important questions or novel applications. A number of open problems were raised, in particular by the invited speakers, some of which are traditionally chosen in neighbouring fields in order to provide the participants with and alternative point of view on the important current directions of research in algorithms and random structures.

On the topics of algorithms, two of the invited speakers delivered wonderful lectures on approximation algorithms (C. Mathieu) and learning (A. Widgerson) which raised many questions and open open problems. J. Gaither presented new results on the number of protected nodes in random tries and suffix trees, which have implications on the performance of algorithms manipulating strings. Probabilistic counting and its applications were addressed in the talks by M. Fuchs and C. Martinez. O. Roussel presented extensions to shuffle products of the widely used Boltzmann samplers. D. Shymura discussed geometric algorithms for shape matching of surprising simplicity which rely on random sampling. C. Fricker demonstrated that the methods can be applied to other concrete problems such as bike sharing systems (BIXI, Vélib'). The other talks on algorithms included B. Vallée's demonstration that Euclid's algorithm is totally Gaussian, J. Fill's recent work on performance of quicksort measured in number of symbol or comparisons, Z. Golebiewski new analysis of leader election based on the trie data structure, E. Gassiat work on lossless compression via adaptive coding for countable alphabets, and I. Eisner application's of domination analysis to scheduling problems.

Discrete probability was addressed in S. Janson's invited lecture on branching processes. Random trees and their properties were also the main topic of the talks of S. Wagner on additive functionals with small toll functions, and V. Kraus on transversal in random trees, which is very surprisingly inspired from applications to antiterrorism. S. Miracle discussed the mixing time of Markov chains on planar triangulations. Urn models and their asymptotic behaviour was the topic of the talks of B. Mocrette (random balanced urns) and M. Kuba (diminishing urns via death processes). G. Fayolle presented his results with K. Raschel on the number of random walks constrained to live in the quarter plane, which has recently generated much interesting research since the proof that the generating function for Gessel's walk is algebraic. Y. Ponty discussed the word collector, a model inspired by the sampling of protein configurations. L. Lhote discussed hidden patterns in strings under general models of sources.

More combinatorial themes were also addressed in M. Drmota's invited lecture on universal results on subcritical random graphs, and A. Coja-Oghlan's introduction to the currently hot topic of phase transitions in random structures and their connection to hardness of optimization problems. Some interesting new aspects of essential combinatorial structures were presented by D. Ralaivaosaona (integer partitions) and V. Feray (random partitions), Z. Gao (random compositions) and P. Jacquet (joint string complexity). The talks on combinatorics also included discussions of less main stream problems such as random subgroups of a free group (F. Bassino), random polyominos in relation to Stokes phenomenon in complex analysis (L. Hickok) and min-weight digital expansions (C. Heuberger).

Moreover, new methodological advances were presented by W. Spzankowski on the asymptotic of solutions of binomial recurrences, J. Cichon on Bernoulli sums, and J. Kieffer on divide-and-conquer recurrences. Furthermore, B. Gittenberger discussed his very recent and far reaching results on Gaussian limit distributions for the solutions of infinite systems of equations. These advances will certainly be central to a number of applications in combinatorics in the future.

(*continued on page* 13)

Workshops

2012 Montréal – Toronto Workshop in Number Theory
"Cycles on Kuga Fibre Varieties"
CRM, May 28 – 29, 2012
Organizers: Eyal Z. Goren (McGill), Stephen S. Kudla (Toronto)

This workshop was dedicated to the study of Kuga fibre varieties and their applications, in particular to the Hodge conjecture, construction of points on elliptic curves and the Griffiths groups, and higher weight versions of Gross – Zagier theory. These recent, and very recent, developments are due to Abdulali, Bertolini – Darmon – Prassana and Mellit. The program included, besides background material aimed mostly at graduate students and junior researchers, several expositions devoted to these emerging directions. Kartik Prasanna (Michigan) presented new work with Darmon, some of it completed the night before (!), and so we are happy to have instigated new research contributions.

As before, the workshop was a resounding success, evident at the level of talks, the participants' engagement and commitment, and the pleasant and cooperative atmosphere surrounding the whole 2 day activity. In addition, during the workshop, through the questions of the audience and discussions, interesting new research directions have emerged. Hopefully, these will be taken by some of the participants.

The Montréal – Toronto workshops, the fourth has just been concluded, are gaining reputation as a fine collaborative initiative between the number theory groups in Montréal and in Toronto, and one of the successful collaborative programs between the CRM institute in Montréal and the Fields Institute in Toronto.

$\mathcal{N} = 2$ Jeometry And ApplicationZ Workshop
McGill University, June 20 – 22, 2012
Organizers: Keshav Dasgupta, Jihye Seo, Johannes Walcher (McGill)

Supersymmetric theories with 8 supercharges (this being $\mathcal{N} = 2$ times the minimal amount required for 4-dimensional Lorentz invariance) are models of relativistic quantum physics that both have nontrivial perturbative and nonperturbative dynamics, and are amenable to exact analysis. Ever since the celebrated solution of $\mathcal{N} = 2$ supersymmetric gauge theory by Seiberg and Witten, the investigation of the rich underlying geometric structure together with its embedding into string theory has proven remarkably fruitful. These developments first of all triggered the discovery of dualities in string theory itself. Secondly, they resulted in an impressive amount of results of relevance to pure mathematics. Thirdly, they have been the starting point for many of the more convincing recent attempts to reconstruct particle physics from a fundamental theory, by breaking $\mathcal{N} = 2$ to $\mathcal{N} = 1$ supersymmetry with branes and fluxes. The last three years have witnessed an impressive revival of interest in $\mathcal{N} = 2$ theories. Among recent results which motivated this workshop, we mention the presentation of a new class of superconformal theories by Gaiotto, their correspondence with certain 2-dimensional (bosonic) conformal theories of Liouville type, as well as the "Nekrasov – Shatashvili" relation between Ω-deformed $\mathcal{N} = 2$ theories and quantum integrable systems, and the embedding of all of the above within string theory.

The scope of the workshop (as hinted by the title) was somewhat larger and included also supersymmetric field theories in other dimensions, and with different amounts of supersymmetry. This framework brought together a number of established researchers, including several of the pioneers, with representatives of the new generation who entered the field in recent years. The goal was to provide a forum for discussion of recent results in the light of original methods and ideas.

The invited speaker of the workshop were: Nathan Seiberg (IAS); Chris Beem (Simons Center); Ken Intriligator (UC San Diego); Philip Argyres (Cincinnati); Sav Sethi (Chicago); Chan Youn Park (Caltech); Jacques Distler (Texas at Austin); Clay Cordova (Harvard); Shlomo Razamat (IAS); David Kutasov (Chicago); Daniel Krefl (UC Berkeley); Peter Koroteev (Minnesota); Amihay Hanany (Imperial College); Satoshi Nawata (Perimeter Institute); Ramadevi Pichai (India Institute of Technology).

The workshop was hosted by the McGill physics department, and the format was modelled after several other successful events organized by McGill's Centre for High Energy Physics about three to four times a year: Two and a half days with around 15 external speakers in a relaxed atmosphere with ample time for discussions. Such a format represents a particular benefit for graduate students around Montréal, who have the opportunity to meet and interact with distinguished scholars in their chosen field of study. As confirmed by many of the participants, the organizers succeeded in striking the right balance this time again. Progress in this branch of mathematical physics is expected to continue at the same amazing pace, and everyone left Montréal looking forward to a future meeting.

AofA 2012

(*continued from page* 12)

The meeting is also traditionally the annual occasion for a community to meet, and a venue where collaborations are started or continued. The coffee breaks and social activities are especially privileged times when work is initiated. This is why we decided to replace the traditional banquet by receptions which were the opportunity to make the participants discover various aspects of Montréal, while leaving more flexibility and focusing on the quality of exchanges between people much more than a formal sitting dinner would permit.

Finally, the authors of abstracts published in the conference have been proposed to submit long versions of their work to a special issue of the journal "Combinatorics, Probability and Computing," which will be dedicated to the memory of Philippe Flajolet in connection with AofA 2012. This special issue edited by N. Broutin (INRIA), J. Fill (Johns Hopkins), Markus Nebel (Kaiserslautern) and M. D. Ward (Purdue) will gather the best contributions and confirm the success of the conference at CRM.

Postdoctoral Fellows

In the academic year 2012 – 2013, the members of the CRM are supervising more than 32 postdoctoral fellows in all fields of mathematics, including 10 which are involved in the activities of the thematic year on *Moduli Spaces, Extremality and Global Invariants*. Some of those postdoctoral fellows are recipients of a CRM – ISM postdoctoral fellowship, which are awarded on merit to promising young researchers from around the world. Those fellowships are awarded for a two-year period and are co-funded by the CRM, the ISM, and the CRM laboratories. Several of the CRM – ISM postdoctoral fellowships are associated with its thematic semesters. These fellowships last between six months and two years.

The members of the CRM are hosting ten new CRM – ISM postdoctoral fellows this year, including six which are associated with the thematic year on *Moduli Space, Extremality and Global invariants*, and three CRM – ISM postdoctoral fellows which were renewed for the second year of their fellowship.

CRM – ISM 2012 – 2013 Postdoctoral Fellows

Jessica Banks, D.Phil., University of Oxford, 2012
Supervisor: Steven Boyer (UQÀM)

I am interested in low-dimensional topology, and in particular knot theory. My work to date focuses on Seifert surfaces and the Kakimizu complex of a knot or link. A Seifert surface for an oriented knot K is a compact, connected, oriented surface with boundary equal to K. The Kakimizu complex $MS(K)$ is a simplicial complex that records the structure of the set of minimal genus Seifert surfaces for K. Vertices of $MS(K)$ are given by ambient isotopy classes of minimal genus Seifert surfaces for K. Distinct vertices span a simplex when they can be realized disjointly in the knot complement.

Adam Harper, Ph.D., University of Cambridge, 2012
Supervisor: Andrew Granville (Université de Montréal)

I work on problems in analytic and probabilistic number theory. This has included the Erdős – Kac central limit theorem for prime divisors; distributional and large deviation results for random multiplicative functions; the distribution of smooth numbers in arithmetic progressions, both individual progressions and on average (in the Bombieri – Vinogradov sense); and constructing S-unit equations with many solutions. At the moment I am working on more projects involving smooth numbers, and also on "inverse questions" about the sharpness of the large sieve inequality (jointly with Ben Green).

Dimitry Kolomenskiy, Ph.D., Université de Provence, 2010
Supervisors: Jean-Christophe Nave (McGill University) and Robert Owens (Université de Montréal)

Many applications in the biological fluid dynamics require a direct numerical simulation of fluid flows in domains with complex moving and deforming boundaries. In my postdoc project, I will work on the development of new computational techniques based on the adaptive multiresolution and volume penalization method for fluid-structure interaction. Further, they will be employed in a study of insect locomotion.

Alejandro Morales, Ph.D. MIT, 2012
Supervisor: François Bergeron (UQÀM)

I work in algebraic and enumerative combinatorics. One specific project that I worked on is counting the number of matrices over a finite field with q elements by rank and with certain entries forced to be zero. These numbers are not always polynomials in q and it is interesting to find families of sets of entries for which they are polynomial. During my stay at LaCIM (Laboratoire de Combinatoire et d'Informatique Mathématique), I plan to further study this question and to find connections between these matrices and factorizations of permutations.

CRM – ISM 2011 – 2012 Postdoctoral Fellows

Vorrapan Chandee, Ph.D., Stanford University, 2010
Supervisors: Chantal David (Concordia University) and Andrew Granville (Université de Montréal)

My main research interest is analytic number theory, focusing on L-functions and problems related to them. Recently, I studied the explicit bounds for functions related to the Riemann zeta function by connecting them with extremal functions. Moreover, I am also interested in moments of L-functions. Currently, I am working on understanding moments of Dirichlet twists of Hecke L-functions through asymptotic large sieve.

Antonio Lei, Ph.D. Cambridge University, 2010
Supervisor: Henri Darmon (McGill University)

My research interests are in Iwasawa theory. Under the supervision of Professor Tony Scholl, I studied the cyclotomic Iwasawa theory of modular forms in his thesis using machineries from p-adic Hodge theory to describe arithmetic properties of modular forms over a cyclotomic extension of the rational numbers. After my Ph.D., I went to Monash University in Australia to work with Daniel Delbourgo, and studied some aspects of noncommutative Iwasawa theory, generalizing results for cyclotomic extensions to noncommutative p-adic Lie extensions of small dimensions. As a CRM – ISM postdoctoral fellow, I will mainly focus on anticyclotomic Iwasawa theory.

Yakov Savelyev, Ph.D., Stony Brook University, 2008
Supervisors: Octav Cornea and François Lalonde (Université de Montréal)

I work in the area of symplectic geometry and topology, particularly Gromov – Witten and Floer theory. Some of my recent work concerns applications of Gromov – Witten theory in algebraic topology. One new project is toward a geometric construction of some multiplicative cohomology theories via topology of the compactified moduli space of Riemann surfaces. In parallel, I am also working on Hofer geometry and the theory of spectral invariants.

CRM Thematic Postdoctoral Fellows

Adam Clay, Ph.D., University of British Columbia, 2010
Supervisor: Steven Boyer (UQÀM)

My research is in geometry and topology, with a focus in 3-manifold topology, knot theory, and their overlap with a particular part of group theory. Specifically I am interested in algebraic properties of the fundamental groups of 3-manifolds, and the question of whether or not these groups are left-orderable. The existence of an ordering on a group is a strong algebraic property that, in the case of fundamental groups, often encodes geometric or topological information about the underlying space. For fundamental groups of 3-manifolds, my research connects this algebraic property with the existence of foliations, and with the Heegaard – Floer homology of the manifold.

Ilya Karzhemanov, Ph.D., University of Edinburgh, 2010
Supervisors: Steven Lu (UQÀM) and Peter Russell (McGill University)

My current research interests are in geometry, geometric group theory and number theory. In the last couple of years, I have made a progress in studying arithmetics, moduli and birational geometry of several classes of algebraic varieties. For instance, I was interested in finding examples of symplectic varieties over a number field F, which have Zariski dense set of rational points over F. Up to now, I treated the case of K3 surfaces. I was also interested in the (uni)rationality type problems for moduli spaces of symplectic varieties, again, in the case of K3 surfaces had been treated. On the other hand, I was interested in developing general criteria for algebraic varieties to be (uni)rational, and also in studying the group of polynomial automorphisms of the affine space.

Egor Shelukhin, Ph.D., Tel Aviv University, 2012
Supervisors: Octav Cornea and François Lalonde (Université de Montréal)

My research has mainly dealt with questions in symplectic geometry. More specifically I have used methods originating in Kähler geometry and quantization to construct invariants of paths in the group of Hamiltonian diffeomorphisms.

David Sher, Ph.D., Stanford University, 2012
Supervisors: Dmitry Jakobson and Frédéric Rochon (McGill University)

My research is in spectral theory, with a particular focus on global spectral invariants such as the determinant of the Laplacian. I am also interested in studying spectral theory on singular and noncompact spaces, often by making use of techniques from geometric microlocal analysis.

Carl Tipler, Ph.D., Université de Nantes, 2012
Supervisor: Vestislav Apostolov (UQÀM)

Kähler geometry is the study of complex manifolds using metrics and tools coming from Riemmanian geometry. A problem suggested by Calabi is to understand when a Kähler manifold admits a better Riemmanian metric, a so-called extremal metric. By the work of Yau, Tian, Donaldson and Székelyhidi, the existence of an extremal metric should be equivalent to a GIT stability of the manifold. During my thesis, I constructed new examples of extremal metrics using perturbative methods including gluing constructions and complex deformations. The interaction between analysis and algebraic geometry enables to understand the deformation theory of extremal manifolds in terms of finite-dimensional GIT. This lead Rollin and I to a description of the deformation theory of these manifolds in the toric case. I am now interested by generalizations of this theory to T-varieties and also by nearby geometries such that Sasakian geometry or the study of HYM connections.

Bulent Tosun, Ph.D., Georgia Institute of Technology, 2012
Supervisors: Olivier Collin and Steven Boyer (UQÀM)

My research is in the areas of geometry and topology of low-dimensional manifolds and symplectic and contact topology. Specifically I am interested in problems about Legendrian and transverse knots in contact 3-manifolds and what they have to say about the existence and uniqueness of contact and symplectic structures on 3- and 4-dimensional manifolds. Such knots have been fundamental objects of study in contact and symplectic topology for long time. My research exhibits many new phenomena about the structure of Legendrian and transverse knots. The understanding of these knots sometimes requires some sophisticated tools such as Floer homology and J-holomorphic curves. Part of my current and future work makes use of these tools.

Accromαth

La revue Accromαth lauréate du prix Anatole Decerf

Accromαth est une revue semi-annuelle produite par l'Institut des sciences mathématiques et le Centre de recherches mathématiques. S'adressant surtout aux étudiants et enseignants d'école secondaire et de cégep, la revue est distribuée gratuitement dans les écoles secondaires et les cégeps du Québec.

Le 15 juin 2012, Accromαth a reçu le prix Anatole Decerf. Attribué tous les deux ans par la Société mathématique de France, ce prix récompense des travaux d'enseignement ou de vulgarisation de la pédagogie des mathématiques. Les membres du jury ont souligné la haute qualité scientifique et pédagogique de la revue.

Math-2013

Accromαth est partenaire de « Mathématiques de la planète Terre 2013 » (MPT 2013). Cette initiative internationale, sous le patronage de l'UNESCO, souligne le rôle essentiel des mathématiques dans la compréhension de notre planète et de ses écosystèmes et dans la recherche de solutions pour la protéger.

Accromαth publiera donc un numéro spécial en 2013 sur le thème des mathématiques de la planète Terre. Dans les archives, tous les articles pertinents pour les enseignants qui veulent creuser plus à fond cette thématique ont été identifiés avec l'icône 2013.

International Workshop on Perspectives on High-Dimensional Data Analysis II

CRM, May 30 – June 1, 2012
Organizers: S. Ejaz Ahmed (Brock), Abbas Khalili (McGill), David A. Stephens (McGill), Éric Marchand (Sherbrooke), Peter X. Song (Michigan), Ji Zhu (Michigan)

This workshop went very smooth and was a huge success. Besides domestic participants, it had attracted many international participants from USA, and some European countries. Many participants at end of the workshop had indicated their interest to take part in a future workshop of a similar type to further discuss research progress in these research areas, and we plan to do so! This workshop has successfully fulfilled the agenda of promoting research activities in the area of high-dimensional data analysis. It has created a rather focused venue for participants to actively discuss and exchange research ideas via presentations and postpresentation informal discussions. The list of speakers at the workshop was really impressive, and most of talks were based on unpublished and on-going work. There is a significant proportion of Canadian speakers, who had been given this opportunities to develop future collaborations among them and with researchers from other countries. The two keynote lectures were of the highest quality.

Essentially all the biological functions in our bodies are carried out by proteins. The specific function of a protein is in turn determined by its 3D structure. Since it is quite time consuming and expensive to conduct laboratory experiments to obtain a protein's 3D structure, it is very desirable to be able to computationally predict the 3D structure of a protein out of its amino acid sequence. This problem, known as protein folding, is long standing in biology, dating back to Anfisen's ground breaking (Nobel prize) work in the 1950s. The difficulty of protein folding lies in two folds: first, we do not have a good energy function that can accurately capture the interactions between the different parts of the protein due to our lack of detailed scientific understanding; second, even with a perfect energy function, it is still extremely difficult to obtain the 3D structure because the energy function has a huge number of local minimums, which can easily trap a search algorithm. Efficient algorithms that can effectively explore the vast space of all possible conformations (3D structures) are critical. In Samuel Kou's talk, a new Markov Chain Monte Carlo algorithm for exploring the conformation space of a protein, Fragment Regrowth via Energy-guided Sequential Sampling (FRESS), is introduced. The key ingredient of FRESS is to delete a randomly selected fragment of varying length from the current conformation and then regrow the deleted fragment in each iteration of the algorithm. This regrowth of the fragment is carried out by energy-guided importance sampling so that conformations with lower energies have higher probabilities to be sampled. In particular, the fragment regrowth is done one backbone atom at a time through sequential Monte Carlo. This sequential scheme allows FRESS to avoid being trapped at local minimums in the conformation space. To utilize the information from known protein structures, the sequential placement of the backbone atoms is guided by the existing 3D structures in the PDB (protein databank) so that the bond angles and torsion angles frequently appearing in the existing protein structures have a higher probability to be sampled. It is demonstrated in the talk that for about 700 test proteins, the FRESS algorithm is able to fold them into a conformation with 5 RMSD (root mean squared distance) of the true structure (within 5 RMSD is considered a gold standard). This talk has updated us the progress of research in this field, and pitched out open problems to motivate young researchers for promising research directions. A highly relevant concern in statistics is how to deal with the high dimensional data that has become so prevalent in recent experiments and studies. These types of data occur in genomics, astronomy, and finance as well as other fields. Thus it is not unusual that the numbers of variables to be considered are in the hundreds of thousands while the sample size is three thousand or less. The classical statistical techniques are designed for the case where the number of variables is less than the sample size, so new methods are now required. In Kjell Doksum's talk, he discussed a set of approaches based on Principal Component Analysis (PCA). In this approach, when investigating the association between a variable and a response, the other variables are replaced by their first k principal components, where k is ten or less. In this way the dimension is reduced to ten or less. The hope is that the first k principal components capture the relevant information in the sense that they can be used to remove any confounding effects. Kjell Doksum gave a result showing when this approach provides non spurious tests of association between a variable and a response. He also reviewed methods based on PCA and compared them with a new proposed nonparametric approach. This talk opens many new research problems in a host of applications.

In addition, 31 invited talks were presented by influential researchers on various aspects of High-dimensional Data Analysis and were well received by the audience. Most of presentations had followed with insightful comments and interesting discussions. A poster session was also organized during reception time to showcase the recent work of graduate students. This was also well attended. Participants had active exchanges ideas and in-depth discussion on current research activities and future research directions.

We would like to express our thanks to the superb staff and management at CRM for the encouragement and support in the organization of this workshop. Our special thanks go to Louis Pelletier (CRM) and Pat Miller (Brock University) for their time and effort.

Workshops

Sage Days 38
CRM, May 7 – 11, 2012
Organizers: Franco Saliola, Srečko Brlek, Sébastien Labbé (UQÀM)

In early May 2012, the CRM hosted Sage Days 38. The audience included researchers of all levels, from undergraduates embarking on summer research projects to established researchers, as well as university and CEGEP educators. The main speakers were Meinolf Geck (Aberdeen), Viviane Pons (Paris-Est Marne-la-Vallée), Derek Ruths (McGill), Anne Schilling (UC Davis), Øyvind Solberg (NTNU), Nicolas M. Thiéry (Paris Sud), and Doron Zeilberger (Rutgers).

The goal of the workshop was twofold: to provide a gentle introduction to Sage for newcomers, and to develop and implement algorithms for mathematics research. All participants were encouraged to come equipped with their own research problems that could benefit from some computational experimentation.

We designed the schedule of the workshop with these goals in mind. We had a rigid schedule for the first few days of the week and an evolving schedule for the last two days. Almost all of the presentations were scheduled for the morning sessions. The afternoon sessions were dedicated to follow-up discussions, working on tutorial exercises (new users) and coding sprints (developers). We ended every day with a "status report" where participants would describe their progress.

Since one of these was to provide a gentle introduction to Sage, there was a strong emphasis on tutorials. This made the workshop very popular, and we had a great turnout (58 participants). It seems that there is a large appetite for workshops that introduce new research tools! We had seven one-hour tutorials throughout the week, lead by various Sage developers: "Using the Sage notebook and navigating the help system", F. Saliola; "Calculus and Linear Algebra in Sage," F. Saliola; "Programming in Python and Sage," F. Hivert; "Contributing to Sage," A. Schilling; "Introduction to Cython," S. Labbé; "Cython," F. Hivert; and "Introduction to the Sage's category theory framework," N. M. Thiéry.

The tutorials offered practical experience for the participants: relevant notions were introduced and then the participants were tasked with exercises.

In addition to the presentations and tutorials on Sage, there were several mathematical presentations. These began by acquainting the audience with the relevant mathematics and then described some of the computational aspects of the theory, together with relevant software packages. Note that some of this software is independent of Sage, and that these talks also served as a means to establish communication between the developers of the different software packages.

At the end of the week we sent out a questionnaire asking for comments on the week. We asked for comments on the schedule, and whether the tutorials and presentations were adapted to their needs as a beginner, user or developer of Sage. The responses were very positive (see the attached answers to the questionnaire). There was some criticism on the pace of the tutorials as a few participants felt the tutorials were a "bit rushed." However, they expressed gratitude for the scheduled free time that they used to review the tutorials and work on the exercises. Some participants went from user to developer over the course of the week, making their very first contributions to Sage. Several participants emphasized that they liked the daily status reports, that it was a good motivator, a good way to see what the other participants where working on during the week and see the progress made over the week.

We feel that the workshop was very successful. The responses to the questionnaire were overwhelmingly positive. New users left emboldened with new skills that they can build upon in the future. The workshop resulted in several contributions to Sage, from fixing of bugs, to adding new functionality and it established communication between different software projects. There will be plenty of research publications emerging as new tools and algorithms are developed. We look forward to their developments.

Coxeter Groups Meet Convex Geometry
LaCIM, UQÀM, August 13 – 22, 2012
Organizers: Christophe Hohlweg (UQÀM), Carsten Lange (FU Berlin), Jean-Philippe Labbé (FU Berlin) Vivien Ripoli (UQÀM)

There are numerous examples of relations between convex geometry and Coxeter groups, the most known probably being the construction of the Tits cone. During these last years, many interesting other examples have been thoroughly studied, among them: generalized associahedra and permutahedra of finite reflection groups; Cambrian fans; brick polytopes and multiassociahedra; imaginary cones and infinite root systems.

These nice encounters between Coxeter groups and convex geometry have two main consequences: we manage to better understand the combinatorics and geometry of Coxeter groups by encoding some of their characteristics in polytopal or more general convex constructions; we also obtain new families of interesting polytopes, which is very useful in convex geometry since such families are fairly rare.

The aim of this meeting was to bring together experts and interested people of both communities, in order to learn from each other and to discuss together new avenues that can be explored. The first week of the meeting was dedicated to minicourses, while the second week was organized to encourage collaborations and discussions.

About 30 researchers coming from Europe (France, Italy), Australia or North America (Canada and USA) attended both the minicourses and the workshop. We were very pleased to see that the objectives we set were reached: many collaborations started during this meeting, and a second "Coxeter groups Meet Convex Geometry" meeting will be organized within two years most certainly in Europe.

2012 CRM – SSC Prize
Changbao Wu (University of Waterloo)

Professor Changbao Wu, from the Department of Statistics and Actuarial Science at the University of Waterloo, is the 2012 winner of the CRM – SSC Prize. Awarded annually by the Centre de recherches mathématiques (Montréal) and the Statistical Society of Canada (SSC), this prestigious prize recognizes a statistical scientist's professional accomplishments in research during the first fifteen years after earning a doctorate.

Changbao Wu

This prize highlights Changbao's outstanding contributions to survey sampling and his exceptional mentoring of graduate students. Changbao also distinguished himself with extended service to his institution, the SSC, and several scholarly journals. The author or co-author of over 30 scientific articles, Changbao has done fundamental work on calibration methods; in particular, he showed how to construct optimal estimators of various finite-population parameters by exploiting auxiliary information efficiently through a model-calibration approach. The general framework he developed for model-assisted calibration methods stimulated much research. More recently, Changbao has focused his interest on empirical likelihood methods for survey data. He is one of the leading developers of pseudo empirical likelihood techniques and the efficient computational algorithms he developed in this context are widely used.

Throughout the years, Changbao also seized many opportunities to get his hands dirty with data. For example, he gained first-hand experience with fishery abundance survey design and analysis. He also played a key role in the Chinese leg of the International Tobacco Control Policy Evaluation Project. In recognition of his leadership role in survey sampling, he was invited to serve as Associate Editor for *Biometrika*, the *Journal of Nonparametric Statistics*, *Survey Methodology*, *The Australian and New Zealand Journal of Statistics*, and of course *The Canadian Journal of Statistics*. Advisor or co-advisor of three Ph.D. students and more than 10 M.Math. students at the University of Waterloo, Changbao is also appreciated for his community contributions. He served on numerous committees at his institution and within the SSC; among others, he was President of the Survey Methods Section in 2005 – 2006.

Born in 1963, Changbao was raised in a small village in the Chinese province of Anhui. His parents and older brother, now deceased, were peasants; they never received any formal education. The village's first elementary school only opened in 1969. Changbao was part of the first class of students; he was the only one to go on to secondary school. After the Cultural Revolution, Changbao was able to study mathematics at Anhui Laodong University. He graduated in 1982 and was hired as a faculty member at the Anhui Institute of Education, a training centre for high school teachers; the institution later became Hefei Normal University. At the beginning of his career, Changbao was younger than most of his students. An energetic and passionate teacher, he was called "Mr. Towel" because when he taught in the summer, he would bring nothing in class except a towel to wipe off sweat.

Changbao completed an M.Sc. diploma in Mathematical Statistics at East China Normal University in 1986. Nine years later, he left his job to pursue doctoral studies in statistics in Canada. He completed his Ph.D. at Simon Fraser University in 1999. His thesis entitled "The effective use of complete auxiliary information from survey data" was written under the supervision of the late Randy Sitter. Changbao was always a great teacher but in the 13 years since he joined the University of Waterloo, he has apparently managed to elevate his teaching to a level such that he no longer even needs a towel to teach!

Changbao is not only a statistician. He is also an avid athlete. He was a member of his college's long distance running team, with best finish in 10 km races at 31:29. He has been playing in the NBA (Non-professional Basketball Association) since 1982. He also enjoys playing badminton and squash with his colleagues and students.

Changbao and his wife Jane recently celebrated their 25th wedding anniversary. They have two daughters: Domeny is a graduate student in the School of Accounting and Finance at the University of Waterloo; Miranda is currently in 5th grade of elementary school. Both girls are very bright and athletic; they enjoy travelling with the family and all kinds of outdoor activities.

Changbao Wu is the 14th recipient of the CRM – SSC prize. Changbao delivered the CRM – SSC Prize in Statistics Address at the 40th Annual Meeting of the Statistical Society of Canada held in Guelph, Ontario, June 3 to 6, 2012.

À paraître / To Appear

CRM Monographs Series, volume 31

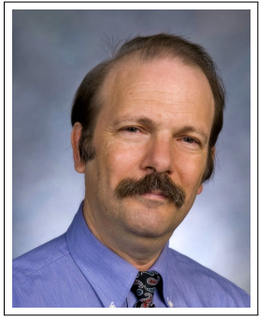
La formule des traces tordue d'après le *Friday Morning Seminar*

de Jean-Pierre Labesse et Jean-Loup Waldspurger.
Avant-propos de Robert Langlands

La formule des traces pour un groupe réductif connexe arbitraire est due à James Arthur. Le cas tordu a fait l'objet du *Friday Morning Seminar* à l'Institute for Adanced Study de Princeton pendant l'année académique 1983-1984. Lors de ce séminaire, des exposés ont été présentés par Laurent Clozel, Jean-Pierre Labesse et Robert Langlands. Les notes de ces exposés, redigées dans l'urgence, avaient besoin d'être revues et complétées. L'ambition des auteurs du présent ouvrage est de donner, en s'appuyant sur ces notes, une preuve complète pour la formule des traces tordue, dans sa version primitive, c.-à-d. sa forme non invariante. Ceci est la première étape du projet de l'équipe parisienne animée par Laurent Clozel et Jean-Loup Waldspurger, dont le but est de donner une preuve complète de la stabilisation de la formule des traces tordue, qui est l'outil fondamental utilisé par James Arthur dans son livre à paraître sur l'endoscopie tordue pour le groupe linéaire avec application aux groupes symplectiques et orthogonaux.

The trace formula for an arbitrary connected reductive group over a number field was developed by James Arthur. The twisted case was the subject of the Friday Morning Seminar at the Institute for Advanced Study in Princeton during the 1983 – 1984 academic year. During this seminar, lectures were given by Laurent Clozel, Jean-Pierre Labesse and Robert Langlands. Having been written quite hastily, the lecture notes of this seminar were in need of being revisited. The authors' ambition is to give, following these notes, a complete proof of the twisted trace formula in its primitive version, i.e., its noninvariant form. This is a part of the project of the Parisian team led by Laurent Clozel and Jean-Loup Waldspurger. Their aim is to give a complete proof of the stable form of the twisted trace formula, and to provide the background for the forthcoming book by James Arthur on twisted endoscopy for the general linear group with application to symplectic and orthogonal groups.

Erratum



Moshe Vardi

Due to a mix-up, we published in our Spring 2012 issue of the Bulletin the wrong photo illustrating the article on the Grande Conférence of Professor Moshe Vardi (Karen Ostrum George Professor in Computational Engineering and Director of the Ken Kennedy Institute for Information Technology, Rice University). Here is Professor Vardi.

We apologize for the inconvenience to Professor Vardi and our readers.

CRM Proceedings & Lecture Notes, volume 55

Complex Analysis and Potential Theory

edited by André Boivin and Javad Mashreghi

This is the proceedings volume of an international conference entitled Complex Analysis and Potential Theory, which was held to honour the important contributions of two influential analysts, Kohur N. GowriSankaran and Paul M. Gauthier, in June 2011 at the Centre de recherches mathématiques (CRM) in Montréal. More than fifty mathematicians from fifteen countries participated in the conference. The twenty-four surveys and research articles contained in this book are based on the lectures given by some of the most established specialists in the fields. They reflect the wide breadth of research interests of the two honourees: from potential theory on trees to approximation on Riemann surfaces, from universality to inner and outer functions and the disc algebra, from branching processes to harmonic extension and capacities, from harmonic mappings and the Harnack principle to integration formulae in $\mathbb{C}^n$ and the Hartogs phenomenon, from fine harmonicity and plurisubharmonic functions to the binomial identity and the Riemann hypothesis, and more. This volume will be a valuable resource for specialists, young researchers and graduate students from both fields, complex analysis and potential theory. It will foster further cooperation and the exchange of ideas and techniques to find new research perspectives.

CRM Proceedings & Lecture Notes, volume 56

Analysis and Geometry of Metric Measure Spaces

edited by Galia Dafni, Robert J. McCann, and Alina Stancu

This book contains lecture notes from most of the courses presented at the 50th anniversary edition of the Séminaire de Mathématiques Supérieures in Montréal. This 2011 summer school was devoted to the analysis and geometry of metric measure spaces, and featured much interplay between this subject and the emergent topic of optimal transportation. In recent decades, metric measure spaces have emerged as a fruitful source of mathematical questions in their own right, and as indispensable tools for addressing classical problems in geometry, topology, dynamical systems, and partial differential equations. The summer school was designed to lead young scientists to the research frontier concerning the analysis and geometry of metric measure spaces, by exposing them to a series of minicourses featuring leading researchers who highlighted both the state-of-the-art and some of the exciting challenges which remain. This volume attempts to capture the excitement of the summer school itself, presenting the reader with glimpses into this active area of research and its connections with other branches of contemporary mathematics.

Nouvelles du Laboratoire de statistique du CRM

Depuis le 1er juin, la direction du Laboratoire de statistique du CRM est assurée par Christian Genest (McGill). Il remplace Louis-Paul Rivest (Laval), qui occupait le poste depuis cinq ans.

Plusieurs membres du Laboratoire se sont distingués ces derniers mois. Citons la nomination de Nadia Ghazzali au rectorat de l'Université du Québec à Trois-Rivières, l'accession de Christian Léger (Montréal) à la présidence de la Société statistique du Canada (SSC) et celle de Christian Genest à la direction de l'Institut des sciences mathématiques du Québec (ISM). De plus, Russell Steele (McGill) assume dorénavant la présidence du Groupe de biostatistique de la SSC, en plus d'être directeur des services électroniques de la Société. Enfin, Éric Marchand (Sherbrooke) a récemment été nommé membre du Comité d'évaluation 1508 du CRSNG.

Jim Ramsay

Au chapitre des hommages, mentionnons l'élévation de Jim Ramsay au rang de membre honoraire de la SSC. Retraité de McGill depuis 2009 mais toujours actif en recherche, Jim s'est vu conférer ce titre « pour son rôle de premier plan dans le développement de l'analyse de données fonctionnelles et la modélisation de processus dynamiques ; pour ses contributions à la psychométrie ; pour avoir constamment promu l'emploi des meilleures méthodes statistiques en recherche ; et pour son mentorat auprès des jeunes statisticiens. » L'annonce a été faite en juin, lors du 40e congrès de la SSC, à Guelph (Ontario).

Toujours en juin, Christian Genest est devenu – à la suite de Louis-Paul Rivest l'an dernier – le second membre honoraire de l'Association des statisticiennes et statisticiens du Québec (ASSQ). L'un et l'autre ont été salués « pour leur contribution à l'avancement de la statistique, l'excellence de leurs travaux et leurs efforts de promotion du rôle de statisticien. »

Plusieurs autres prix et distinctions ont récemment été dévolus à des membres du Laboratoire. C'est ainsi par exemple que Debbie Dupuis (HEC) a reçu le titre d'Ancienne de l'année et s'est vu attribuer « Le prisme » par la Faculté des sciences de l'Université de Moncton en guise de reconnaissance pour une carrière de recherche remarquable en sciences. Pour sa part, Thierry Duchesne (Laval) est le seul Canadien à avoir été élevé au rang de membre de l'Institut international de statistique ; ce statut, considéré comme un privilège, est attribué par cooptation.

À McGill, Robert Platt a été nommé « Chercheur national » par le Fonds de recherche du Québec – Santé. À Concordia, le dévouement de José Garrido envers la Faculté des sciences a été souligné par un prix. À l'Université de Montréal, l'enseignement de David Haziza lui a valu un prix institutionnel et Yoshua Bengio s'est mérité des honneurs pour son « Manifold Tangent Classifier » lors du 25e congrès annuel NIPS, tenu en Espagne. Enfin, Pierre Lafaye de Micheaux et ses coauteurs, Rémy Drouilhet et Benoît Liquet, ont été finalistes du prix Roberval 2012 pour leur manuel intitulé *Le logiciel R, maîtriser le langage – effectuer des analyses statistiques.*

Pour de plus amples nouvelles et des détails concernant les réalisations des membres du Laboratoire, consulter la page `http://crm.math.ca/labs/stat/fr/`.

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Le Centre de recherches mathématiques (CRM) a vu le jour en 1969. Actuellement dirigé par François Lalonde, il a pour objectif de servir de centre national pour la recherche fondamentale en mathématiques et leurs applications. Le personnel scientifique du CRM regroupe plus d'une centaine de membres réguliers et de boursiers postdoctoraux. De plus, le CRM accueille chaque année entre mille et mille cinq cents chercheurs du monde entier.

Le CRM coordonne des cours de cycles supérieurs et joue un rôle prépondérant (en collaboration avec l'ISM) dans la formation de jeunes chercheurs. On retrouve partout dans le monde de nombreux chercheurs ayant eu l'occasion de parfaire leur formation en recherche au CRM. Le Centre est un lieu privilégié de rencontres où tous les membres bénéficient de nombreux échanges et collaborations scientifiques.

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