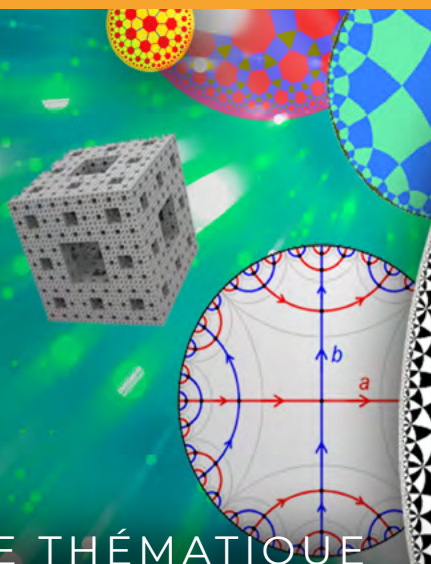
CENTRE DE RECHERCHES MATHÉMATIQUES

Le Bulletin du CRM

Volume 28, numéro 1, Hiver/Winter 2023



SEMESTRE THÉMATIQUE

Théorie géométrique des groupes

Janvier – juin 2023
January – June 2023

page 4

En bref / *At a glance*

Le Bulletin du CRM

Volume 28 no 1
Hiver 2023

Le Bulletin du CRM est une lettre d'information à contenu scientifique, faisant le point sur les actualités du Centre de recherches mathématiques (CRM).

ISSN 1492-7659

Le Centre de recherches mathématiques (CRM) est un des plus importants centres de recherche en mathématiques du monde. Fondé en 1968 à l'Université de Montréal, le CRM regroupe les forces vives en mathématiques des universités québécoises et d'autres universités canadiennes, tout en organisant des activités auxquelles participent des mathématiciens et mathématiciennes provenant de tous les horizons et des quatre coins du globe. La structure double sur laquelle le CRM est construit — une programmation exigeante de niveau international en parallèle avec treize laboratoires de recherche de haute performance — est unique. Le personnel scientifique du CRM regroupe quelques 240 membres réguliers et accueille chaque année dans ses laboratoires plus de 80 stagiaires postdoctoraux ainsi qu'un grand nombre de chercheuses et chercheurs invités.

Le CRM tient à remercier ses divers partenaires pour leur appui financier à sa mission : le Conseil de recherches en sciences naturelles et en génie du Canada, le Fonds de recherche du Québec–Nature et technologies, la Fondation Simons, le Centre national de recherche scientifique, la National Science Foundation, l'Université de Montréal, l'Université du Québec à Montréal, l'Université McGill, l'Université Concordia, l'Université Laval, l'Université de Sherbrooke, l'Université d'Ottawa, ainsi que les fonds de dotation André Aisenstadt, Serge Bissonnette et Robert Langlands.

Directrice d'édition : Galia Dafni
Révision : Marion Cesari
Paula Rossi
Vincent Masciotra
Conception graphique : Pierre Lavallée

Centre de recherches mathématiques
Université de Montréal
C.P. 6128, succ. Centre-ville
Montréal, QC. H3C 3J7
Téléphone : 514 343-7501
Courriel : CRM@CRM.UMontreal.CA

Le Bulletin est disponible à :
https://www.crmath.ca/rayonnement-et-publications/publications/bulletins/

ABONNEMENT/DÉSABONNEMENT
SUBSCRIBE/UNSUBSCRIBE
https://www.crmath.ca/infolettre/

Abonnez-vous à nos pages sur les réseaux sociaux pour garder contact :

CRM_Montreal
Centre de recherches mathématiques
Centre de recherches mathématiques (CRM)
Activites CRM

MOT DU DIRECTEUR

Ça bouge au CRM

L'automne 2022 est bien chargé au CRM : un semestre thématique – Symétries en algèbre et physique – d'une exceptionnelle intensité se conjugue avec des activités du plus haut niveau, dont certaines ouvertes au grand public, telle que la Grande Conférence du 8 septembre ayant comme conférencier James Maynard, récent lauréat de la médaille Fields et ancien stagiaire postdoctoral CRM-ISM.

D'autres points à relever :

- Le mode de communication hybride s'est généralisé pour la majorité de nos activités menant à une expansion sensible de nos audiences.
- Le nouveau site web du Centre est en développement continu et supplante de plus en plus l'ancien. L'infolettre bimensuelle rentre dans nos habitudes.
- Un comité de sensibilisation, en collaboration avec l'ISM, a vu le jour pour coordonner et promouvoir nos activités à l'échelle du Québec.
- Le programme ***«En Avant Math!»*** est en train de connaitre une rapide expansion, en réponse aux besoins en numératie de la population québécoise. .
- Le personnel du Centre poursuit son évolution et son adaptation au monde post-pandémique dans des conditions toujours changeantes.
- La Professeure Galia Dafni s'est jointe à l'équipe du CRM comme Directrice adjointe en charge des publications et communications rejoignant ainsi Benoit Durand-Jodoin, Directeur adjoint – administratif et le Professeur Alexandre Girouard, Directeur adjoint – activités scientifiques.

Le financement de base du centre est assuré pour les cinq années à venir à la suite du processus de renouvellement de nos subventions de la part du CRSNG et du FRQ qui s'est conclu au mois de juin 2022. Le niveau stable du support nous garantit la continuation de nos programmes, cependant les augmentations rapides des prix nous touchent aussi. Des efforts significatifs sont déployés de façon proactive pour répondre à ces pressions budgétaires. D'ailleurs, la communauté du CRM a eu récemment l'occasion d'en discuter lors d'une table ronde bénéficiant de la présence de Alejandro Adem, Président du CRSNG, et de Janice Bailey, Directrice scientifique du FRQ-NT.

La communauté du CRM a répondu de façon exemplaire devant les défis des années pandémiques. La réussite de tout ce que le Centre entreprend dépend de la poursuite de cet engagement pendant les années à venir.

Je vous remercie donc de rester engagés et de garder le CRM au centre de vos projets scientifiques.

Octav Cornea

On the go at the CRM

The fall of 2022 is very busy at the CRM: a thematic semester - Symmetries in Algebra and Physics - of exceptional intensity is combined with activities of the highest level, some of which are open to the general public, such as the Grande Conference of September 8 by James Maynard, recent Fields Medal winner and former CRM-ISM postdoctoral fellow.

Other points to note:

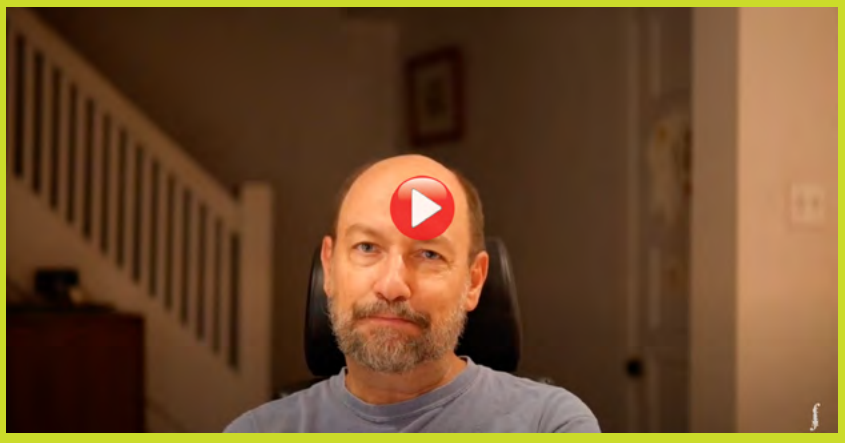
- *The hybrid communication mode has become widespread for the majority of our activities, leading to a significant expansion of our audiences.*
- *The Centre's new website is under continuous development and is increasingly supplanting the old one. The bi-monthly newsletter is becoming a regular feature.*
- *An outreach committee, in conjunction with the ISM, has been formed to coordinate and promote our activities across Québec.*
- *The "En Avant Math!" program is rapidly expanding in response to the numeracy needs of the Québec population.*
- *The Centre's staff continues to evolve and adapt to the post-pandemic world under ever-changing conditions.*
- *Professor Galia Dafni has joined the CRM team as Deputy Director in charge of publications and communications, joining Benoit Durand-Jodoin, Deputy Director - Administration and Professor Alexandre Girouard, Deputy Director - Scientific Activities.*

The core funding of the Centre is assured for the next five years following the renewal process of our grants from NSERC and the FRQ, which was concluded in June 2022. The stable level of support ensures the continuation of our programs; however, rapid price increases also affect us. Significant efforts are being made proactively to address these budgetary pressures. The CRM community recently had the opportunity to discuss these issues at a roundtable discussion with Alejandro Adem, President of NSERC, and Janice Bailey, Scientific Director of the FRQ-NT.

The CRM community has responded in an exemplary fashion to the challenges of the pandemic years. The success of all that the Centre undertakes depends on the continuation of this commitment for years to come.

Thank you for staying committed and keeping the CRM at the center of your scientific projects.

Octav Cornea



Octav Cornea

© Alina Stancu

CRM Call for Proposals

The CRM calls for proposals for:

- *scientific activities, in particular thematic programs starting from 2026;*
- *outreach activities, in particular activities related to Pi Day 2023 (March 14). Most of these activities will be supported by the program En Avant Math!;*
- *activities in support of EDI goals.*

In all cases, proposals consisting of a description of the event together with a justification of interest and a provisional budget should be submitted at proposals@crm.umontreal.ca.

For detailed information on submission guidelines please consult the webpage Organizing an Activity.

Le CRM lance un appel à propositions

Le CRM lance un appel à propositions pour :

- des activités scientifiques, en particulier des programmes thématiques à partir de 2026;
- des activités de sensibilisation, en particulier des activités pour la journée Pi de 2023 (le 14 mars prochain). La plupart de ces activités seront soutenues par le programme En Avant Math!;
- des activités à l'appui des objectifs d'EDI.

Dans tous les cas, les propositions consistant en une description de l'événement accompagnée d'une justification d'intérêt et d'un budget prévisionnel doivent être soumises à projets@crm.umontreal.ca.

Pour plus d'informations sur les lignes directrices de présentation de propositions, veuillez consulter la page Organiser une activité.

CRSNG NSERC | Fonds de recherche Nature et technologies Québec | SIMONS FOUNDATION | NSF

Geometric Group Theory

Overview

This thematic semester focuses on advances in Geometric Group Theory and aims at a number of research directions where there has recently been exciting progress. There will be six intense periods of activity devoted to "measured group theory", "huge groups", "ordered groups", "geometry of subgroups", "3-manifold groups", and "cube complexes and generalizations". These will have mini-courses aimed at training the next generation of researchers and conferences devoted to research talks that highlight recent developments.

Organizers

Daniel Wise (McGill University)
Steven Boyer (Université du Québec à Montréal)
David Futer (Temple University)
Mark Hagen (University of Bristol)
Piotr Przytycki (McGill University)
Anush Tserunyan (McGill University)
Genevieve Walsh (Tufts University)

Aisenstadt Chairs

Ruth Charney (Brandeis University)
Zlil Sela (Hebrew University of Jerusalem)

Program activities

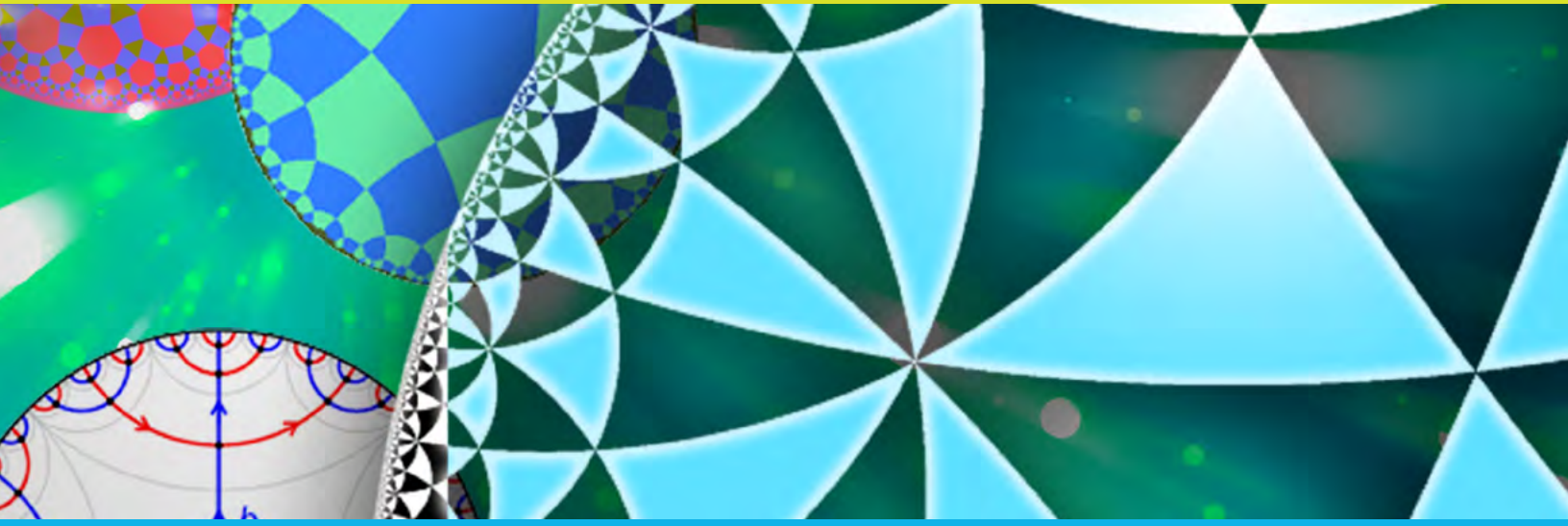
Measured Group Theory

March 6 - 17, 2023

Measured group theory looks at groups from a probabilistic perspective, by studying their actions on probability spaces up to orbit equivalence. It turns out that the orbit equivalence relations of these actions can remember information about the group, which has yielded classification and rigidity results, as well as new invariants such as cost, ℓ^2-Betti numbers, and ergodic dimension. Initiated by Gromov and Zimmer, the subject has become a very fruitful area of research over the last 25 years. One reason for this is that to study the orbit equivalence relation of an action, one tries to measurably equip the orbits with various combinatorial and geometric structures (graphs, trees, CW-complexes) and investigate their characteristics (colorings, matchings, ends, ℓ^2-Betti numbers), which often requires machinery from the corresponding subjects, and also contributes back to these subjects with new results. This two-way traffic has established new connections between Measured Group Theory and various different areas, including ergodic theory, descriptive set theory, probability theory, combinatorics, geometric group theory, Lie groups, and von Neumann algebras.

The first week of the workshop will offer mini-courses given by leading researchers: Damien Gaboriau (CNRS/ENS de Lyon), Tsachik Gelander (Weizmann), Gabor Kun (Rényi), Tianyi Zheng (UC San Diego). The second week will be devoted to research talks.

Université de Montréal | UQÀM | Université de Sherbrooke | Université Laval | McGill | uOttawa | Université Concordia University



Huge Groups

April 3 - 6, 2023

This 4-day mini-school focused on "huge" groups, such as the Cremona group and its subgroups, the homeomorphism group of a surface, the mapping class group of an infinite-type surface, a general Artin group. They can be studied through non-proper actions on nonpositively or negatively curved combinatorial spaces. It will consist of four minicourses, by Sebastian Hensel (Munich), Anne Lonjou (Basque Country/Paris Saclay), Kathryn Mann (Cornell), and Alexandre Martin (Heriot-Watt). It will also include research talks by Yves Cornulier (Lyon), George Domat (Utah), and Thomas Koberda (Virginia).

The course topics are:

- *Fine curve graphs (Sebastian Hensel)*
- *Acylindricity of the Cremona group (Anne Lonjou)*
- *Structure of homeomorphism groups (Kathryn Mann)*
- *Geometry of Artin group actions (Alexandre Martin)*

Orderable Groups

April 24 - May 5, 2023

The focus of these activities is on the algebraic and dynamical aspects of ordered group theory. Introductory mini-courses will be given in the first week by Adam Clay (Manitoba), Tyrone Ghaswala (Waterloo), Thomas Koberda (Virginia) and Andrés Navas (Santiago). The second week will be devoted to research talks covering recent advances in both the theory of ordered groups and their applications in group theory, dynamics and low-dimensional topology.

The course topics are:

- *Introduction to order structures in groups (Adam Clay)*
- *Introduction to circular orderings (Tyrone Ghaswala)*
- *Orders and dynamics (Thomas Koberda)*
- *Spaces of orderings, with applications (Andrés Navas)*

Geometry of Subgroups

May 15 - 26, 2023

Understanding the geometry of the finitely generated subgroups of a group informs our understanding of that group significantly. For example, some hyperbolic groups enjoy the property that every finitely generated subgroup is quasi-convex. Groups which are incoherent and groups which are algebraically fibered do not have this property. This conference aims to explore some of the many directions in this field, including quasi-convexity in other contexts.

Mini-courses will be given by Carolyn Abbott (Brandeis), Kasia Jankiewicz (UC Santa Cruz), Rob Kropholler (Warwick), Jean Pierre Mutanguha (Institute for Advanced Study), and Jason Manning (Cornell).

Groups Around 3-Manifolds

June 5 - 16, 2023

This workshop focuses on several themes related to the fundamental groups of 3-manifolds. The themes include: the theory character varieties, Thurston norm polytopes and fibrations, orderability, profinite rigidity, and variations on the Cannon conjecture. The first week of the workshop will feature mini-courses by Ian Biringer (Boston College), Michelle Chu (Minnesota), Nathan Dunfield (Illinois-Urbana), Daniel Groves (Illinois-Chicago), and Henry Wilton (Cambridge). The second week will be devoted to research talks.

Cube Complexes and Combinatorial Geometry

June 19 - 30, 2023

The mini-courses and research talks will address several themes, including: nonpositively-curved cube complexes, median spaces, (coarsely) Helly spaces and groups, and various combinatorial notions of nonpositive curvature. The first week of the workshop involves mini-courses by Elia Fioravanti (MPI Bonn), Thomas Haettel (Montpellier), Nima Hoda (ENS Paris), Nir Lazarovich (Technion). The second week will be devoted to research talks.

JUILLET — DÉCEMBRE 2023 / JULY – DECEMBER 2023

Modéliser et simuler le cerveau

Survol

Avec l'émergence de capacités de calcul grandissantes, le raffinement de modèles mathématiques décrivant les processus neuraux et physiologiques et l'émergence de réseaux de neurones artificiels inspirés par la biologie, la capacité de modéliser le cerveau et sa fonction au-delà d'approximations simplistes émerge. Ces nouvelles avancées ouvrent la porte à la création de modèles réalistes et des descriptions simulées du cerveau et de sa fonction qui pourraient fournir des clés permettant de comprendre les dysfonctions cérébrales.

Ce semestre thématique sera dévoué aux modèles. À la simulation du cerveau en amenant des experts associés à ces thématiques à présenter leurs travaux récents et à discuter des perspectives associées à la modélisation du cerveau. Trois sous-thèmes seront abordés lors de conférences ciblées de 2 semaines : l'intelligence artificielle d'inspiration biologique, les modèles vasculaires et métaboliques du cerveau et la modélisation neurale à partir de données d'imagerie.

Afin de mettre la table et démarrer les activités, une école d'été s'intitulant « Analyse harmonique et multifractale : des mathématiques aux neurosciences » mettra en place une série de cours et séminaires sur les aspects méthodologiques et d'analyse du signal.

Comité organisateur

Frédéric Lesage (Polytechnique Montréal)
Karim Jerbi (Université de Montréal)
Habib Benali (Concordia University)
Bratislav Misic (Montréal Neurological Institute (MNI))
Hervig Wendt (Université de Toulouse)
Adrien Peyrache (McGill University)
Patrice Abry (ENS Lyon)
Farida Cheriet (École Polytechnique de Montréal)
Sylvie Lorthois (Institut de méchanique des fluides de Toulouse (UMR CNRS 5502))
Jean-Marc Lina (École de technologie supérieure)
Nicola Wilten (University of Calgary)
Andreas Linninger (University of Illinois Chicago)
Michèle Desjardins (Centre de recherche CHU de Québec)

Chaire Aisenstadt

Stéphane Jaffard (Université Paris-Est Créteil)

Activités du programme

Analyse harmonique et multifractale : des mathématiques aux neurosciences

3 au 14 juillet 2023

Cette école d'été de 2 semaines ciblera la description/caractérisation/analyse et modélisation de dynamiques complexes et invariantes d'échelles dans les fonctions, processus, images et champs. Cette description sera déployée sous le regard de différents champs scientifiques, de la théorie aux applications concrètes.

Le programme démarre avec l'analyse harmonique et fractale, développée par les mathématiciens et progressera vers des applications concrètes en analyse du signal et de l'image, distinctes mais toutes centrées sur les neurosciences et la neurophysiologie, vers la fin de l'école d'été.

L'objectif principal est de promouvoir des échanges interdisciplinaires afin de permettre une meilleure transition des développements récents en analyse vers les applications. Une attention particulière sera portée sur les données à grande dimension ou grand nombre de variables.

Avancées en neuro-IA

18 au 29 septembre 2023

En 1952, Alan Hodgkin et Andrew Huxley ont initié une activité de modélisation mathématique des systèmes neuraux avec la prédiction de l'évolution du voltage, ou potentiel de membrane, de l'axone géant de calmar. Cette découverte s'est faite par la modélisation de la dynamique du voltage de membrane à l'aide d'équations différentielles ordinaires. Elle a mené à la création des neurosciences computationnelles, et plus récemment, à la création de réseaux de neurones bio-inspirés.

L'un des objectifs communs de ces deux initiatives est de comprendre comment la dynamique neuronale, la connectivité des réseaux et les fonctions des réseaux ou la dynamique macroscopique sont liées. Dans l'apprentissage automatique, cette perspective a été inversée, en commençant par la dynamique ou la fonction du réseau et en appliquant des techniques de la théorie de l'optimisation pour déterminer la connectivité sous-jacente du réseau. De manière impressionnante, ces techniques peuvent même maintenant être appliquées à des réseaux de neurones modèles similaires à ceux mis en avant pour la première fois par Hodgkin et Huxley.

L'atelier associé à ce thème visera à explorer les dernières avancées dans ces deux domaines en amenant des experts en neurosciences computationnelles et dans le domaine de l'intelligence artificielle à interagir et présenter leurs derniers travaux.

Modélisation vasculaire et métabolique du cerveau à grande échelle

10 au 20 octobre 2023

Alors que la fonction neurale est centrée sur le neurone, son énergie est supportée par le système vasculaire. Avec le développement récent de modèles détaillés de la circulation cérébrale entière, il est maintenant devenu possible de simuler le cerveau animal et humain de façon réaliste sur un ordinateur. La modélisation du débit, de la pression, des cellules rouges peut maintenant être faite dans des cerveaux entiers et peut aussi être étendue à la diffusion de l'oxygène au tissu. L'intégration de cette livraison d'oxygène à des compartiments décrivant les cellules neurales et gliales promet une description synthétique du cerveau qui pourrait ouvrir l'étude de pathologies, et même permettre des prédictions sur leurs effets et sur certains biomarqueurs.

Cet atelier de deux semaines présentera les derniers développements dans le domaine de la simulation vasculaire et physiologique sous forme de conférences/cours, ateliers et présentations de recherche.

Inférerence de réseaux de neurones à partir de l'imagerie électrophysiologique et fonctionnelle

20 novembre au 1 décembre 2023

Le cerveau contient près de 100 milliards de neurones. Quoique les études antérieures de la fonction cérébrale se concentraient sur la fonction et le couplage local, il est maintenant reconnu que la réseautique du cerveau est essentielle pour appréhender sa fonction. Notamment, de récents progrès dans la science des réseaux ont été essentiels afin de simuler la connectivité fonctionnelle du cerveau et prédire les états cérébraux.

En parallèle, plusieurs efforts ont été faits au cours des dernières années afin de dériver les modèles de réseau à partir de données issues de l'imagerie. Utilisant des modèles inverses et probabilistes, les réseaux et leurs changements avec les pathologies ont été caractérisés.

Cet atelier couvrira les notions de dynamique de réseau, abordera ces concepts à travers l'étude des derniers développements dans l'étude des réseaux cérébraux dérivés de données d'imagerie et des méthodologies associées pour modéliser le cerveau.

Description :

Depuis trois ans, le Centre de recherches mathématiques (CRM) et le CIRANO collaborent à l'établissement d'une stratégie visant à favoriser le développement d'une main-d'œuvre hautement qualifiée en mathématiques appliquées pour des domaines de pointe. L'initiative nationale ***« En avant math ! »***, sous la direction de Genevieve Dufour, Directrice des grands projets de collaboration CIRANO, a pour objectif de promouvoir les mathématiques et accroître la numératie. Cette initiative est appuyée financièrement par le ministère des Finances du Québec (MFQ). Lors de ce forum, les travaux réalisés durant ces trois années de partenariat ainsi que les prochaines étapes du projet ont été présentés.

De gauche à droite :

***Raquel Fonseca**, professeure à l'UQAM et membre du CIRANO;*

***Nathalie de Marcellis-Warin**, directrice du CIRANO;*

***Luc Castonguay,** Ministère des Finances du Québec;*

***Geneviève Dufour**, directrice des grands projets, CIRANO;*

***Octav Cornea**, professeur à l'UdeM et directeur du CRM;*

***Nathalie Auger**, Ministère de l'emploi et de la solidarité sociale du Québec;*

***Louise Poirier**, Professeure honoraire à l'UdeM et Responsable du Projet Numératie En avant Math ! au CRM*

En Avant Math !
Appel à projets d'activités sur le terrain

Dans le cadre d'***En Avant Math!***, nous lançons un troisième appel à projets d'activités sur le terrain. Ces activités s'adresseront à divers publics : préscolaire, primaire et secondaire incluant des activités parents-enfants, collégial et universitaire ainsi que des activités pour le grand public. Elles seront mises en place dans différentes régions du Québec.

Les subventions octroyées peuvent soutenir des programmes ou activités déjà mis en place ou des nouveaux programmes ou activités. Parmi les dépenses admissibles : salaires, déplacements, fournitures et matériaux pour soutenir ces activités. Par contre, les sommes obtenues ne peuvent servir à soutenir des projets de recherche.

Les projets déposés seront évalués par un comité.

YOSHUA BENGIO


© Mila

Yoshua Bengio
Université de Montréal

Intelligence artificielle : entre généraliser et comprendre

28 octobre 2021

Pour la première grande conférence publique en présentiel depuis le début de la pandemie le 28 octobre 2021, le CRM a invité Yoshua Bengio. Les 125 places en présentiel et les 500 places sur Zoom se sont rapidement envolées, si bien qu'il a été decidé de diffuser aussi en direct la conférence sur YouTube.

La conférence a comporté deux parties. Dans la première partie, le conférencier a presenté les grands succès de l'intelligence articielle depuis 2010 : reconnaissance de la voix, reconnaissance d'images, structure spatiale des protéines.

La deuxième partie de la conférence a porté sur les grands défis : celui de la dimensionnalité, celui de la composabilité, et surtout celui de la généralisation. Ce dernier défi demande de sortir de l'hypothèse qu'on a des variables aléatoires indépendantes identiquement distribuées (iid). Les humains structurent leurs connaissances en morceaux réutilisables : parmi ceux-ci, les mécanismes causaux sont ceux qui permettent de généraliser hors-distribution. Comment intégrer de tels mécanismes, soit des biais inductifs, dans l'apprentissage machine ? L'humain est supérieur à la machine dès que la tâche sort de la routine et demande une attention et une réflexion de tous les instants, alors que la machine accomplit très bien tout ce que l'humain fait inconsciemment et qui correspond à des connaissances non verbalisables. C'est la partie verbalisable du savoir humain, celle du raisonnement qui pose le plus grand defi pour l'apprentissage machine. L'objectif de l'apprentissage profond 2.0 est de réussir à modéliser les mécanismes causaux, soit ce qui permet d'imaginer ce qui pourrait se passer selon les actions posées : cela demande d'apprendre aux ordinateurs à decouvrir ces mécanismes causaux par analyse des données.

La conférence a fasciné l'auditoire et suscité de nombreuses questions. C'était un retour en présentiel très réussi pour un public heureux de retrouver les Grandes conférences publiques.

Christiane Rousseau

Pour écouter sa conférence

Biographie

Yoshua Bengio est professeur titulaire au Département d'informatique et de recherche opérationnelle de l'Université de Montréal, ainsi que fondateur et directeur scientifique de Mila et directeur scientifique d'IVADO. Reconnu comme l'un des plus grands experts mondiaux en intelligence artificielle et en apprentissage profond, il est colauréat, avec Geoff Hinton et Yann LeCun, du Prix A.M. Turing 2018, considéré comme le « prix Nobel de l'informatique ». Il est à la fois Fellow de la Royal Society de Londres et de la Société Royale du Canada, Officier de l'Ordre du Canada et titulaire d'une chaire en IA Canada-CIFAR.

GRANDES CONFÉRENCES PUBLIQUES DU CRM

DANS LE CADRE DES 24 HEURES DE SCIENCE 2022

© Richard Poissant

Frédéric Gourdeau
Université Laval

Quel effet a le mot mathématique sur vous?

6 mai, 2022

Pour ma part, cela évoque des idées simples qui permettent de voir plus clairement même lorsqu'un problème semble très complexe. Je pense au plaisir qu'elles me procurent : découvrir, explorer et comprendre pourquoi. Je ressens la satisfaction que provoque la résolution d'un problème que j'ai trouvé coriace. Et je songe au fait que derrière la résolution de problèmes se cachent des idées mathématiques géniales.

J'entends aussi des mots comme magie, ludique, spectacle, atelier, et j'en passe. Pourquoi ?! Parce le défi de faire aimer les maths est immense et important, et que l'on doit faire preuve d'imagination et de créativité pour rejoindre le plus de jeunes possible, dans toutes les communautés. Plus on sera nombreuses et nombreux à y travailler, avec ouverture et en collaboration avec le monde enseignant, mieux on y parviendra.

Les maths magiques et ludiques, c'est une manière de le faire. Que cachent-elles, que révèlent-elles? Venez le découvrir, que vous soyez novice ou expert!

Pour écouter sa conférence

Biographie

Frédéric Gourdeau a obtenu son doctorat en analyse fonctionnelle de l'université de Cambridge en 1989. Il est professeur au Département de mathématiques et de statistique de l'Université Laval, dont il a été directeur de 2010 à 2018, et président de l'Association mathématique du Québec (AMQ). Son travail en formation des enseignants du primaire et du secondaire jumelé à sa passion pour la résolution de problèmes l'ont amené à fonder l'Association québécoise des jeux mathématiques (AQJM), laquelle chapeaute un concours de mathématiques ludiques (21 000 participants en 2019) ainsi que le site de la Semaine des maths (en collaboration avec le projet SMAC de Jean-Marie De Koninck). Ce travail a permis le développement d'activités pour les enseignants et leurs élèves de tous les niveaux, tels que magie mathématique, énigmes, parcours ludiques, défi évasion, spectacles et ateliers. Récipiendaire de plusieurs prix en enseignement, dont le Prix national 3M d'excellence en enseignement (2006), il s'est aussi mérité le prix Adrien Pouliot 2014 de la Société mathématique du Canada pour sa contribution exceptionnelle à l'enseignement des mathématiques au Canada.

JAMES MAYNARD

James Maynard
University of Oxford

La magie des nombres premiers

8 septembre 2022

C'est devant une salle comble que James Maynard a donné sa grande conférence publique sur la magie des nombres premiers. Le conférencier a expliqué que les nombres premiers sont les blocs de base des nombres entiers à la manière des atomes en chimie et, en même temps, très mystérieux. On sait qu'il y a une infinité de nombres premiers, mais quantifier de manière précise combien il y en a jusqu'à X est relié à l'hypothèse de Riemann, un des grands problèmes ouverts du 21e siècle. Pourtant, les nombres premiers nous concernent tous puisque le système cryptographique sur lequel reposent nos transactions financières sur internet est basé sur le fait qu'il est difficile pour un ordinateur de factoriser un produit de deux grands nombres premiers $n = pq$. Par contre, la factorisation est facile si, par exemple, $p - 1$ n'a que des petits facteurs premiers. Cela suggère la question :

Q1. Combien y a-t-il de nombres premiers p tels que $p - 1$ n'a que des petits facteurs premiers ?

Ici la réponse est connue et on sait qu'il y en a peu. Mais, par prudence, il est recommandé de se limiter à des nombres premiers p tels $(p - 1)/2$ est premier. D'où la nouvelle question :

Q2. Combien y a-t-il de nombres premiers p tels que $(p - 1)/2$ est premier ?

On croit qu'il y en a beaucoup, mais la question est ouverte.

Le conférencier a ensuite bifurqué vers le dernier théorème de Fermat prouvé seulement 350 ans plus tard par Andrew Wiles. Il a démontré qu'il suffisait de montrer le théorème pour des exposants premiers. Déjà en 1820, Sophie Germain avait montré une version faible du théorème de Fermat pour les entiers premiers p tels que $2p + 1$ est premier. On retrouve exactement la question **Q2** : les mêmes questions théoriques étudiées depuis des siècles ont des applications pratiques importantes.

Pour finir, le conférencier a abordé la question des écarts entre nombres premiers et ses propres résultats. Quoique la conjecture des entiers premiers jumeaux (à savoir l'existence d'une infinité de paires d'entiers premiers p, $p + 2$) soit encore ouverte, un des grands théorèmes de James Maynard est qu'il existe un entier pair $k \leq 246$ tel qu'il existe une infinité de paires d'entiers premiers p, $p + k$. Ce grand résultat parmi d'autres, ainsi que la polyvalence des outils developpés par le conférencier, font partie des raisons pour lesquelles James Maynard vient de se voir octroyer la médaille Fields en juillet 2022. Durant toute la conférence, James Maynard a capté l'attention du public, lequel a longuement étiré la soirée grâce à des discussions animées lors du vin d'honneur.

Christiane Rousseau

Pour écouter sa conférence

Biographie

James Maynard a fait son doctorat à Oxford en 2013. Après des stages postdoctoraux au CRM à Montréal, à Berkeley, à Princeton et à Oxford il est devenu professeur au Mathematical Institute d'Oxford en 2017.

James Maynard travaille sur la distribution des nombres premiers et, plus particulièrement sur les écarts entre nombres premiers. Dès son doctorat, il a obtenu des résultats spectaculaires. Ceux-ci lui ont valu de nombreux prix, dont un prix Erdös et le prix SASTRA Ramanujan en 2014, un prix Whitehead en 2015 et un prix de l'European Mathematical Society en 2016. En 2022, sa recherche a été couronnée par la médaille Fields.

A CELEBRATION OF ANALYTIC NUMBER THEORY, A CONFERENCE IN HONOR OF ANDREW GRANVILLE

From left to right:
Terence Tao, Dimitris Koukoulopoulos, Matilde Lalin, Andrew Granville, James Maynard, Frédéric Bouchard – Doyen, Faculté des arts et des sciences

© Richard Poissant

Organizers: *C. David, D. Koukoulopoulos, M. Lalín, J. Maynard, K. Ono and K. Soundararajan*

A week-long conference in Analytic Number Theory was held in Montreal in the first week of September, gathering experts and junior participants to discuss and share the recent spectacular progress in the field, and to honour the many important contributions of Andrew Granville on the occasion of his 60th birthday, which made the event very special for many.

It is difficult to imagine a more spectacular decade than the last one for analytic number theory, with significant progress on so many long-standing open questions by a stellar new generation of analytic number theorists. To mention a few, the breakthrough work of Maynard on gaps between primes, that of Matomäki and Radziwiłł on averages of multiplicative functions and Chowla's conjecture, and that of Harper on the distribution of random multiplicative functions, have been incredibly influential. In the topics described above, the work of Andrew Granville has been substantial and extremely influential, both by doing foundational work and by mentoring several of the new key players in the field. It is striking that Harper, Matomäki, Maynard and Radziwiłł were all mentored by Andrew as students or post-doctoral fellows!

The celebrations began on Sunday afternoon, as Andrew insisted on hosting a garden party at his house in the Laurentians for all the friends, collaborators, mentees, and mathematicians at large which were in Montreal on that day. After a week of bad weather, the sky magically cleared for the occasion, and we all gathered in the garden on a very beautiful day, enjoying gourmet food prepared by Andrew's son Anthony, the company of old friends and Fields Medalists, some croquet, and a guided visit of Andrew and Marci's very impressive garden, including the brand-new greenhouse.

The conference started Monday morning with a beautiful talk by James Maynard, who was a CRM-ISM post-doctoral fellow in Montreal under the supervision of Andrew when he proved his breakthrough result on bounded gaps between primes, which was part of the work recognized in his 2022 Fields Medal citation. Maynard's talk set the stage for all the excellent array of talks that followed that week, many of them given by former students, former postdoctoral fellows, or collaborators of Andrew. The topics varied among analytic number theory, additive combinatorics, Diophantine equations, and arithmetic statistics, a tribute to the numerous areas of number theory which were influenced by Andrew. I will not single out any talks in this ensemble of the highest quality, as they are all listed on the CRM Web page for the event.

It would make no sense to organize a conference for Andrew and not be concerned about the diversity of the participants, since it is a cause that has been very dear to Andrew during all his career, and where he has had a very significant impact. About a third of the speakers were female, many of them former students and post-doctoral fellows of Andrew.

A banquet was held at Mount Stephens hotel on Wednesday night, celebrating Andrew with style in a beautiful decor and with very good food. Marci and Andrew's sons Sebastian and Anthony were also present at the event, and seemed to enjoy the many speeches highlighting Andrew's career and mentorship, along with some gentle bantering...

Due to the pandemic, there were many incertitudes about the conference, and at many times, we feared that it would be cancelled. Many invited speakers and participants could not come because of pandemic related issues, including visa problems, but all sent testimonies via a Koduboard recognizing the influence of Andrew on the field of analytic number theory and on their personal careers. Still, many were able to come and participate in the event, enjoying the high scientific quality of the talks and the warm atmosphere of the event.

On a personal note, I can say that organizing this event was an honour, and an occasion to thank and celebrate Andrew who made my life richer in many ways, as a mentor, as a colleague, and as a friend. A testimony that was shared by many during the conference.

Chantal David

QUÉBEC-MAINE 2022

Conférence de Théorie des Nombres Québec-Maine 2022

Les 15 et et 16 octobre 2022, la 24e Conférence de Théorie des Nombres Québec-Maine se tenait à l'Université Laval pour souligner les 60 ans du professeur Andrew Granville. Granville est l'un des meilleurs mathématiciens au Canada et le CRM a organisé un congrès très important en son honneur au début du mois de septembre. Appuyés par plusieurs collègues, nous avons cru bon que de lui dédier une deuxième conférence en son honneur, laquelle n'était pas de trop ! Notons que ce deuxième événement était cette fois-ci plus court sur la durée, en présence de théoriciens des nombres de tous azimuts, ce qui a offert une opportunité additionnelle et complémentaire de célébrer la théorie des nombres en général, mais plus particulièrement celle qui est en lien avec les intérêts et les recherches de Granville. Le professeur Granville est un mathématicien reconnu dans la communauté internationale des mathématiciens, en particulier dans le domaine de la théorie analytique des nombres. Il a énormément contribué au développement des mathématiques au Canada, en particulier au Québec, (en fait, au niveau mondial) et ses connaissances ont définitivement un effet d'osmose sur la jeune génération.

Environ 100 participants se sont inscrits à cette conference Québec-Maine. Il y a eu une cinquantaine d'exposés, dont 19 par des professeurs de carrière, 10 par des chercheurs post-doctoraux, 14 par des étudiants gradués, et 5 par des étudiants sous-gradués de haut niveau. Officiellement, le professeur Andrew Granville en fut le conférencier plénier distingué, et les professeurs Louis-Pierre Arguin (CUNY) et Samit Dasgupta (Duke U.) furent deux conférenciers pléniers principaux.

Il faut souligner que les conférences Québec-Maine (à l'Université Laval aux années paires) et Maine-Québec (à University of Maine, Orono aux années impaires) sont très intenses et les gens aiment bien ne pas avoir à investir une semaine pour un congrès. Le but de ces réunions est d'offrir aux théoriciens des nombres l'occasion de discuter et d'échanger avec tous et chacun à propos de leurs résultats et de leurs problèmes, et ce, dans une atmosphère très décontractée, pour ne pas dire ludique. Le prix à payer pour un tel congrès, c'est qu'il y a des sessions en parallèle. Bien que les exposés en parallèle portent sur des sujets différents, les choix à faire sont souvent cornéliens. Le dernier orateur fut le professeur Andrew Granville: un merveilleux exposé sur les corps de nombres K pour lesquels une courbe donnée et déffinie sur $\mathbb{Q}$, admet des points K-rationnels (et plus particulièrement les degrés de tels corps K). Il est possible de lire les titres et résumés de tous les exposés sur la toile en tapant : ***Maine-Québec Number Theory Conference***.

Ces congrès Québec-Maine sont maintenant reconnus en Amérique du Nord comme l'endroit parfait pour les étudiants sous-gradués et gradués. Suivant la tradition, le samedi soir nous avons eu droit a un banquet et nous avons bien échangé en compagnie de Bacchus. Le congrès a bénéfficié de soutiens financiers de la part de l'institut TIMC (Institut TUTTE), du centre québécois CRM, de l'institut FIELDS, de la fondation NTF (Number Theory Foundation), du centre CICMA, du journal JNT (Elsevier), de la fondation NSF et de l'Université Laval. Tous ces organismes ont ainsi contribué au développement de la théorie des nombres : théorie et applications.

Hugo Chapdelaine *et* ***Claude Lévesque***

AISENSTADT CHAIR LECTURES

THEMATIC PROGRAM – SYMMETRIES: ALGEBRAS AND PHYSICS

© Richard Poissant

Lauren K. Williams

Harvard University

Macdonald polynomials and the ASEP

September 27, 2022

Combinatorics of hopping particles and positivity in Markov chains

October 3, 2022

The asymmetric simple exclusion process (ASEP) is a model for translation in protein synthesis and traffic flow; it can be defined as a Markov chain describing particles hopping on a one-dimensional lattice. I will give an overview of some of the connections of the stationary distribution of the ASEP to combinatorics and special functions. I will also mention some open problems and observations about positivity in Markov chains.

Schubert polynomials and the ASEP

October 4, 2022

Biography

Lauren K. Williams *is the Dwight Parker Robinson Professor of Mathematics at Harvard University and the and Sally Starling Seaver Professor at the Radcliffe Institute. Her research interests lie in algebraic, enumerative, and topological combinatorics, and their connections with algebraic geometry, representation theory, and physics, in particular: total positivity, cluster algebras, statistical mechanics, and tropical geometry. She received her PhD in 2005 from the Massachusetts Institute of Technology under the supervision of Richard Stanley, and has held positions at MSRI, Université Paris 6, Columbia University, the Institute for Advanced Study and the University of California, Berkeley, before joining Harvard as professor in 2018.*

Professor Williams is the recipient of numerous awards, honors and distinctions, among them being selected as one of the inaugural Fellows of the American Mathematical Society (2012), winning the Association for Women in Mathematics and Microsoft Research Prize in Algebra and Number Theory (2016), being an invited speaker at the International Congress of Mathematicians (2022), and getting a Guggenheim Fellowship (2022).

Rei Inoue

Chiba University

Cluster algebras and combinatorics in representation theory

September 26, 2022

We introduce a cluster realization of Weyl groups for a finite dimensional semi simple Lie algebra, and consider its applications to (1) the geometric R-matrix of symmetric power representations for the affine quantum algebra of A-type, and to (2) the q-characters of quantum non-twisted affine algebras introduced by Frenkel and Reshetikhin, when q is a root of unity.

Cluster algebra and its development

September 27, 2022

The cluster algebra was introduced by Fomin and Zelevinsky around 2000. The characteristic operation in the algebra called "mutation" is related to various notions in mathematics and mathematical physics.

In this talk, after explaining some basics of cluster algebras, I review two important aspects of cluster algebras in algebra of totally positive matrices, and in geometry of punctured surfaces.

Cluster algebras and hyperbolic geometry

September 28, 2022

We introduce an application of cluster algebra to study two and three dimensional hyperbolic geometry.

In two dimension, a mutation corresponds to a flip in ideal triangulations of punctured surfaces, and cluster x-variables give a coordinate for the decorated Teichmuller space of the surface.

In three dimension, a mutation produces an ideal tetrahedron, and cluster y-variables are interpreted as the modulus of ideal tetrahedra. We define the octahedral braiding operator composed of four mutations, and study the volumes of knots.

© Richard Poissant

Biography

Rei Inoue *is a professor at Chiba University in Japan. She is well known for her work on discrete integrable systems, in particular the algebraic and geometric understanding of integrable ball-box type systems. She uses techniques from algebraic geometry, tropical geometry, cluster algebras and combinatorics. She also studies knot invariants and Teichmüller theory by applying cluster algebras.*

Professor Inoue received a PhD in 2001 from the University of Tokyo on the topic of algebraic structures of discrete integrable systems and soliton cellular automata, under the supervision of Miki Wadati. In 2003 she was awarded the MSJ Takebe Katahiro Prize for Encouragement of Young Researchers from the Mathematical Society of Japan.

Duncan Haldane

Princeton University

Topological Quantum Matter, Entanglement, and the Second Quantum Revolution

August 23, 2022

While the laws of quantum mechanics have remained unchanged and have passed all tests for the last eighty-five years, new discoveries about the exotic states that they allow, "entanglement", and ideas from quantum information theory, have greatly changed our perspective, and some believe that a "second quantum revolution" is currently underway. The discovery of unexpected "topological states of matter", and their possible use for "topologically-protected quantum information processing" is one of the important themes of these developments, and will be described.

Quantum Geometry in the Fractional Quantum Hall Effect I

August 24, 2022

The fractional quantum Hall effect was essentially explained by Laughlin's wavefunction for an incompressible, which unexpectedly turned out to be a "conformal block" of a U(1)k chiral conformal field theory in 2+0 dimensions, and which can be interpreted in terms of a elementary object, the "composite boson" which has a topological description in terms of Chern-Simons theory. It also has gapless topological excitations on its edge, described by the same conformal field theory as that of the bulk wavefunction, except now it is a 1 + 1 dimensional chiral cft. Missing from the topological description is the geometrical properties of the composite boson which will provide a structure for the fluid. This is related to the intrinsic electric quadrupole moment of the composite boson, the crucial FQH property is unbroken 2d inversion symmetry. The composite boson and alternative composite fermion picture will be reviewed.

Quantum Geometry in the Fractional Quantum Hall Effect II

August 26, 2022

While "toy models" exist which have a null space which maps into (Euclidean, not Lorentzian) cft, with exact Laughlin, Moore-Read, etc as maximum density states in the null space, the "real" systems with generic interactions break conformal invariance, and some aspects of the model wavefunctions are non-generic, as their geometry is non- conformal and generically.

The reason cft models can be useful in FQH systems is that the Hilbert space (but not the spectrum) of their low-energy edge degrees of freedom is described by a direct product of unitary irreducible representations of the Virasoro algebra. This is second independent occurrence of this algebra in physics, independent of its appearance in cft.

And interesting case is a cft-based "toy model" (called the "Gaffnian" model by its originator, S. Simon) where the cft is non-unitary, with a single negative weight primary. This appears to describe a gapless critical point between two 2/5 FQHE state with composite bosons of opposite 2d-parity.

Interview of Professor Duncan Haldane by UdeM Nouvelles

Biography

***Duncan Haldane** is the Sherman Fairchild University Professor of Physics at Princeton University. He received his PhD in 1978 from Cambridge, under the supervision of Philip Warren Anderson. Before joining Princeton, he held positions at the Institut Laue-Langevin in Grenoble, the University of Southern California, Bell Laboratories, and the University of California, San Diego.*

*Professor Haldane's research is on strongly-interacting quantum many-body condensed-matter systems, explored by non-perturbative methods. It has been recognised by countless awards, most importantly the **2016 Nobel Prize in Physics**, (together with David J. Thouless and J. Michael Kosterlitz) "for theoretical discoveries of topological phase transitions and topological phases of matter". Other honours include the 2008 Lorentz Chair at Leiden University, the 2012 Dirac Medal, and the 2017 Golden Plate Award of the American Academy of Achievement. Professor Haldane is a Fellow of the American Academy of Arts and Sciences since 1992, a Fellow of the Royal Society since 1996, and member of the U.S. National Academy of Sciences since 2017.*

Gustav Lehrer

University of Sydney

Mini course: Invariant Theory-Classical, Quantum and Super

May 26 – June 12, 2022

The first and second fundamental theorems of invariant theory respectively describe a set of generators, and a complete set of relations among these generators, for the space X^U of invariants of a group, Lie algebra, associative algebra, or some other algebraic structure U, acting linearly on a space X. The subject has a very rich history, going back at least to Gauss.

In recent times, there has been significant progress, even in the classical cases of tensor representations of classical groups. This has been partly through the introduction of diagrammatic methods (which really go back to Brauer in 1937), the notion of quantum deformations, which has brought braid groups into the picture, the theory of cellular algebras, which are well adapted to the study of non-semi-simple deformations of semisimple representations and developments in the calculus of ribbons and more general tangles.

These are all applied in a categorical setting, when the invariants concerned can be interpreted in several different ways. I will explain some of the classical background, the new ideas, including algebraic geometric methods and Brauer, Temperley-Lieb and other diagram categories with a braid-like origins.

In the third (and last) lecture, I shall describe some of the recent progress, particularly in the case of super-groups, where the second fundamental theorem is now quite well understood.

Lecture 1

Classical theory for GL(Cn) - the first and second fundamental theorems; Schur-Weyl duality. The case of the classical groups O(n) and Sp(2n). Brauer diagrams; the Brauer category; other categories of tangles.

Lecture 2

Quantum groups and R-matrices; braid group action and strongly multiplicity free modules. Quantum sl_2 and the Temperley-Lieb algebra. Higher representations of quantum sl_2. Cellular algebras. Quantum versions of the second fundamental theorem.

Lecture 3

Supersymmetry: super spaces and super Lie algebras. The Grassmann algebra. Adaptation of a geometric idea of Atiyah; the second fundamental theorem for the ortho-symplectic super group.

Biography

Gus Lehrer *is an Emeritus Professor at the School of Mathematics and Statistics of the University of Sydney. He was also a member of the Pure Mathematics research group. He received his PhD in 1971 at the University of Warwick.*

His research interests include the algebraic and geometric aspects of representation theory; reductive algebraic groups, particularly over finite fields; algebraic geometry, spaces of configurations in algebraic varieties; Hecke and other algebras; cohomological group actions; and knot-theoretic algebra, including diagram algebras and braid groups.

Professor Lehrer is a Fellow of the Australian Academy of Science since 1998 and was an ARC Professorial Fellow (2005 – 2009). He received the Hannan Medal of the Australian Academy of Science (2015), shared the George Szekeres Medal of the Australian Mathematical Society (2016), and became a Member of the Order of Australia (2016).

Isabelle Gallagher

Université Paris-Diderot

Mathematical analysis of dilute gases: derivation of the Boltzmann equation, fluctuations and large deviations

May 16 and 17, 2022

In these two lectures Prof. Gallagher presented some recent advances and open problems related to a statistical approach to the mathematical analysis of dilute gases: the focus was on fluctuations and large deviations around the Boltzmann equation.

May 20, 2022

The evolution of a gas can be described by different models depending on the observation scale. A natural question, raised by Hilbert in his sixth problem, is whether these models provide consistent predictions. In particular, for rarefied gases, it is expected that continuum laws of kinetic theory can be obtained directly from molecular dynamics governed by the fundamental principles of mechanics. In the case of hard sphere gases, Lanford showed in 1975 that the Boltzmann equation emerges as the law of large numbers in the low density limit, at least for very short times. The goal of this talk was to explain the heuristics of his proof and present recent progress in the understanding of this limiting process.

Biographie

Isabelle Gallagher est connue pour ses recherches sur les équations aux dérivées partielles, telles que les équations de Navier-Stokes, l'équation des ondes et l'équation de Schrödinger, ainsi que sur l'analyse harmonique du groupe de Heisenberg. Elle a obtenu son doctorat à l'Université Pierre et Marie Curie en 1998, sous la direction de Jean-Yves Chemin. En 2018 et 2019, elle a dirigé le département de mathématiques et applications de l'École Normale Supérieure (Paris). Depuis 2019, elle est directrice de la Fondation Sciences Mathématiques de Paris.

Parmi ses distinctions: conférencière invitée au congrès international des mathématiciens (ICM) à Séoul en 2014; médaille d'argent du CNRS et le Prix La Recherche (avec Thierry Bodineau et Laure Saint-Raymond) en 2016; Chevalier de l'ordre national du Mérite en 2016; et le Prix Sophie Germain en 2018.

© Cyril Frésillon/CNRS

Bernard Derrida

École Normale Supérieure,
Département de physique, France

The importance of large deviations in non-equilibrium systems

March 18, 2022

Statistical Physics allowed to unify, at the end of the 19th century, Newton's mechanics and thermodynamics. It gave a way to predict the amplitude of fluctuations around the physical laws which were known at that time. Einstein, in his very first works, showed that the measurement of these fluctuations allowed to estimate the size of atoms. His reasoning, which was at the origin of the linear response theory, applied to the black body gave one of the first evidences of the duality wave-particle in Quantum Mechanics. Statistical Physics gives also a framework to predict large deviations for systems at equilibrium. In the last two decades, major efforts were devoted to extend our understanding of the statistical laws of fluctuations and large deviations to non-equilibrium systems. This talk will try to present some of the recent progresses.

Large deviation functions of the density and of the current for diffusive systems

March 24, 2022

After a short review of the different approaches used to determine the large deviation functions of diffusive systems in their steady state, the talk will present a few recent results: 1. How these large deviations functions are modified for weak contacts with the boundaries 2. What is the influence of conditioning on the current on these large deviation functions.

Phase transitions on a tree in presence of disorder and growth-fragmentation models

March 24, 2022

A tree-like model based on a simple non-linear recursion on a tree exhibits a phase transition of infinite order. After a discussion of the precise nature of the singularity at the transition, and on the influence of the distribution of disorder, I will discuss some more recent results on the critical tree at the transition which can be viewed as a growth fragmentation model.

Biographie

Bernard Derrida est un expert en mécanique statistique qui a adapté les idées de la physique statistique à divers problèmes de biologie. Il est surtout connu pour ses travaux en mécanique statistique et est l'éponyme des « Derrida plots » : une technique analytique permettant de caractériser les différences entre les réseaux booléens. Il a obtenu son doctorat en 1979. Depuis 2015, il est titulaire de la chaire de physique statistique au Collège de France.

Élu à l'Académie des sciences en 2004, membre de l'Institut universitaire de France (2007-2015), Derrida a reçu des nombreux prix: le prix Daniel Guinier en 1977, le prix IBM en 1985, le Grand Prix Ampère de l'Académie des Sciences en 2001, la médaille Boltzmann (avec John Cardy) en 2010 et le prix des Trois Physiciens en 2015.

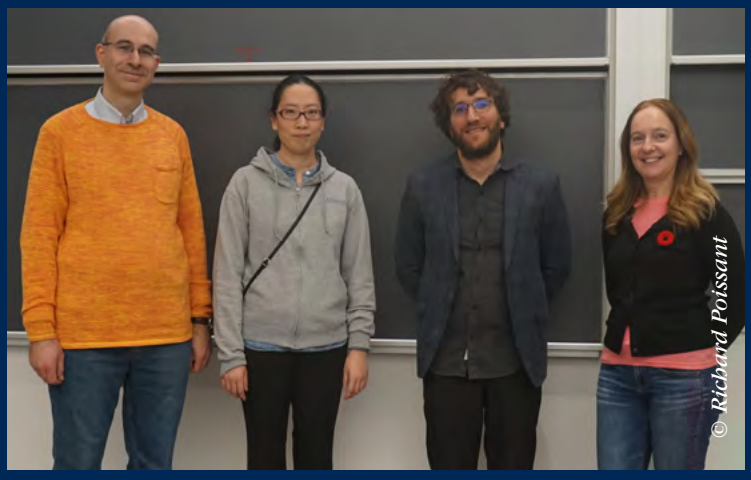
CRM NIRENBERG LECTURES IN GEOMETRIC ANALYSIS

Organizers:

Pengfei Guan (McGill University)
Dmitry Jakobson (McGill University)
Iosif Polterovich (Université de Montréal)
Alina Stancu (Concordia University)

The lecture series is named in honour of Louis Nirenberg, one of the most prominent geometric analysts of our time. Louis Nirenberg was born in 1925 in Hamilton, Ontario. After his family moved to Montréal, he attended Baron Byng High School, followed by McGill University, earning his B.Sc. there in 1945. In 1949 Louis Nirenberg received a Ph.D. from New York University, where he later became a professor at the Courant Institute. His fundamental contributions include the pioneering work on nonlinear PDE techniques in global differential geometry, the Gagliardo-Nirenberg inequalities in the theory of Sobolev spaces, the Agmon-Douglis-Nirenberg theory of elliptic boundary value problems, the John-Nirenberg space of functions of bounded mean oscillation (BMO), the Kohn-Nirenberg theory of pseudo-differential operators, and the Newlander-Nirenberg theorem in complex geometry.

The research achievements of Louis Nirenberg were previously recognized by numerous prizes and awards, such as the National Medal of Science, the Chern Medal, the Crafoord Prize, the Steele Prize, the Jeffery-Williams Prize and the Abel Prize.



From left to right: *Iosif Polterovich (Université de Montréal, director of the ISM); Lu Wang (Yale University); Jacob Bernstein (Johns Hopkins University); Alina Stancu (Concordia University)*

2022

October 31 & November 1, 2022

Lu Wang

Yale University

Biography

Lu Wang *received her PhD in 2011 from MIT. She has held positions at MSRI, Imperial College London, IAS and Caltech. Since July 2021, Lu Wang is a professor in the Department of Mathematics at Yale University. Professor Wang's work in geometric analysis, particularly on special solutions to curvature flows, has been recognized by several grants and awards such as Alfred P. Sloan Research Fellowship and an invitation to speak at the 2022 International Congress of Mathematicians (ICM).*

Lecture 1 - An Excursion into Mean Curvature Flow

Recording: *Lu Wang: An Excursion into Mean Curvature Flow*

Lecture 2 - Self-Shrinkers of Mean Curvature Flow: Progress, Problems, and New Frontiers

Recording: *Lu Wang: Self-Shrinkers of Mean Curvature Flow: Progress, Problems, and New Frontiers*

November 3 and 4, 2022

Jacob Bernstein

Johns Hopkins University

Biography

Jacob Bernstein *received his PhD in 2009 from MIT. After completing an NSF postdoctoral fellowship at Stanford followed by a research fellowship at Cambridge, Jacob Bernstein joined, in 2012, the Department of Mathematics at Johns Hopkins University, where he is currently professor. He is well known for his work on minimal surface theory and mean curvature flow.*

Lecture 3 - Recent Progress on Self-Expanding Solutions of Mean Curvature Flow

Recording: *Jacob Bernstein: Recent Progress on Self-Expanding Solutions of Mean Curvature Flow*

Lecture 4 - Complexity of Submanifolds and Colding-Minicozzi Entropy

Recording: *Jacob Bernstein: Complexity of Submanifolds and Colding-Minicozzi Entropy*

The 2022 Nirenberg Lectures In Geometric Analysis: Jacob Bernstein And Lu Wang

The lectures of the 2022 Nirenberg series were delivered at the CRM by Professor Jacob Bernstein (Johns Hopkins University) and Professor Lu Wang (Yale University) during the week of October 31 - November 4, 2022. Jacob Bernstein is particularly known for his work on minimal surface theory and mean curvature flow. Lu Wang has been recognized by several grants and awards such as an Alfred P. Sloan Research Fellowship and an invitation to speak at the 2022 International Congress of Mathematicians. The two speakers have collaborated on many projects including work that they presented at the CRM during this series of four lectures. The main topics were two classes of special solutions of the mean curvature flow: self-shrinkers and self-expanders.

The series was started by Lu Wang with two lectures focused on recent developments in the study of self-shrinkers. Her first lecture provided an overview of the mean curvature flow with a guided tour in the development of singularities possibly even before the flow becomes extinct in finite time. Self-shrinkers model the asymptotic behavior of the flow when singularities form and they are a special class of solutions to the flow in which a later time slice is a scale-down copy of an earlier one. In her second lecture, Wang discussed various existence and uniqueness results for self-shrinkers. In regards to the classification of self-shrinkers, she pointed out several tools that were employed successfully in recent years such as gluing techniques and variational approaches. In R3, these resulted in proving the existence of self-shrinkers of each genus, and, generally, the existence of infintely many shrinkers in R^{n+1} for $2 \leq n \leq 6$. Though the space of self-shrinkers is large and complex, the only entropy stable self-shrinkers are hyperplanes, round spheres and generalized cylinders. Self-shrinkers of low entropy are expected to have simple geometry and a result obtained in joint work with Jacob Bernstein confirms it. Several other open questions were presented.

The last two lectures were delivered by Jacob Bernstein. His first lecture introduced the audience to self-expanders of the mean curvature flow. A class of special solutions of the flow that moves by scaling outward, self-expanders are particularly interesting as they model how certain singularities are resolved. While self-shrinkers scale down and model the behavior of mean curvature flow when a singularity forms, self-expanders model the behavior of mean curvature flow when it emerges from a cone-like singularity. Bernstein discussed some recent work on uniqueness properties of self-expanders and their consequences. In particular, even though there may be non-uniqueness of self-expanders for general cones, for simple enough cones as measured by entropy, they are unique in some topological sense. Bernstein's second lecture was on the complexity of submanifolds and Colding-Minicozzi entropy. He surveyed recent progress in the study of Colding-Minicozzi entropy of hypersurfaces. One particular example was his joint work with Lu Wang which shows that closed hypersurfaces with small entropy are simple in various senses.

For the first time since their inception in 2014, the CRM Nirenberg lectures took place in hybrid mode. They were well attended both in presence and online, particularly the opening and the closing lectures of the series which engaged a general mathematical audience.

Alina Stancu

2021

October 1 and 5, 2021

Bo'az Klartag

Weizmann Institute of Science

Biography

Professor Bo'az Klartag is one of the world's leading researchers in geometric analysis. He obtained his PhD from Tel Aviv University in 2004, which he later joined as a professor. Professor Klartag is well known for his fundamental contributions to the field of asymptotic geometric analysis and, in particular, to the study of high-dimensional phenomena. In recognition of his outstanding accomplishments, Professor Klartag was invited to speak at the 2006 ICM in Madrid, and has been awarded the 2008 European Mathematical Society Prize as well as the 2010 Erdös Prize. He is currently professor at the Weizmann Institute of Science.

Lecture 1 - Convexity and High-Dimensional Phenomena

Video of the presentation

High-dimensional problems with a geometric flavor appear in a number of branches of mathematics and mathematical physics. A priori, it seems that the immense diversity observed in high dimensions would make it impossible to formulate general, interesting theorems that apply to large classes of high-dimensional geometric objects. In this talk we will discuss situations in which high dimensionality, when viewed correctly, induces remarkable order and simplicity rather than complication. For example, Dvoretzky's theorem demonstrates that any high-dimensional convex body possesses nearly-Euclidean sections of large dimension. Another example is the central limit theorem for convex bodies, according to which any high-dimensional convex body has approximately-Gaussian marginals. There are strong motifs in high-dimensional geometry, such as the concentration of measure, which appear to compensate for the large number of different configurations. Convexity allows us to harness these motifs in order to formulate elegant and non-trivial theorems.

Lecture 2 - Isoperimetry in convex bodies and Eldan's stochastic localization

Video of the presentation

The Kannan-Lovasz-Simonovits (KLS) conjecture is concerned with the isoperimetric problem in high-dimensional convex bodies. The problem asks for the optimal way to partition a convex body into two parts of equal volume so as to minimize their interface. The conjecture suggests that up to a universal constant, the optimal solution is obtained by bisecting the convex body with a hyperplane. Some years ago it was proven that the KLS conjecture implies Bourgain's slicing conjecture. Recently, Chen has made significant progress towards the KLS conjecture, which utilizes the technique of Stochastic Localization by Eldan. In this lecture we will explain this method, and survey various results on isoperimetry and spectral gap under convexity assumptions.

October 6 and 8, 2021

Yuansi Chen

Duke University

Biography

A graduate of École Polytechnique in Paris, Dr. Yuansi Chen obtained his PhD in Statistics from UC Berkeley in 2019. After a postdoctoral fellowship in Data Science at ETH Zürich, Dr. Yuansi joined last year the faculty of the Department of Statistical Science at Duke University. While a researcher in Zürich, he made huge progress in a 25 year old conjecture proposed by Kannan, Lovász and Simonovits. It is a major breakthrough with many implications for central questions ranging from statistics and computer science to high-dimensional geometry, where the resolution of the KLS conjecture provides an answer to the slicing problem posed by Bourgain.

Lecture 1 - Recent progress on the Kannan-Lovasz-Simonovits (KLS) conjecture and Bourgain's slicing problem I

Video of the presentation

Kannan, Lovász, and Simonovits (KLS) conjectured in 1995 that the Cheeger isoperimetric coefficient of any log-concave density or any convex body is achieved by half-spaces up to a universal constant factor. This conjecture now plays a central role in the field of convex geometry, unifying or implying older conjectures. In particular, it implies Bourgain's slicing conjecture (1986) and the thin-shell conjecture (2003). While it is natural to expect convex bodies to have good isoperimetry (in other words, not look like dumbbells), the progress on bringing down the Cheeger isoperimetric coefficient in the KLS conjecture has been stagnant in recent years. The previous best bound, with dimension dependency d^1/4, was established by Lee and Vempala in 2017 using Eldan's stochastic localization, and matches the best dimension dependency Klartag obtained in 2006 for Bourgain's slicing conjecture.

After becoming familiar with Eldan's stochastic localization technique in the previous lecture, first we aim to get familiar with the concept of «localization» and to view stochastic localization as an extension. Then we go through the Lee and Vempala (2017) proof to see in action a concrete application of stochastic localization.

Lecture 2- Recent progress on the Kannan-Lovasz-Simonovits (KLS) conjecture and Bourgain's slicing problem II

Video of the presentation

In recent work, Chen (2020) improved Eldan's stochastic localization proof technique, which was deployed in Lee and Vempala (2017), to prove an almost constant Cheeger isoperimetric coefficient in the KLS conjecture with dimension dependency d^o(1). Consequently, his proof also provides a substantial advance toward the resolution of Bourgain's slicing conjecture and the thin-shell conjecture.

After getting conformable with Eldan's stochastic localization technique, in this talk we navigate through how to refine the technique to provide the current best bound. We will complete the self-contained proof of Chen (2020) and highlight the new ideas involved. Finally, we will discuss some extensions and provide an outlook for future research directions.

Séminaire de mathématiques supérieures 2022 : Floer Homotopy Theory

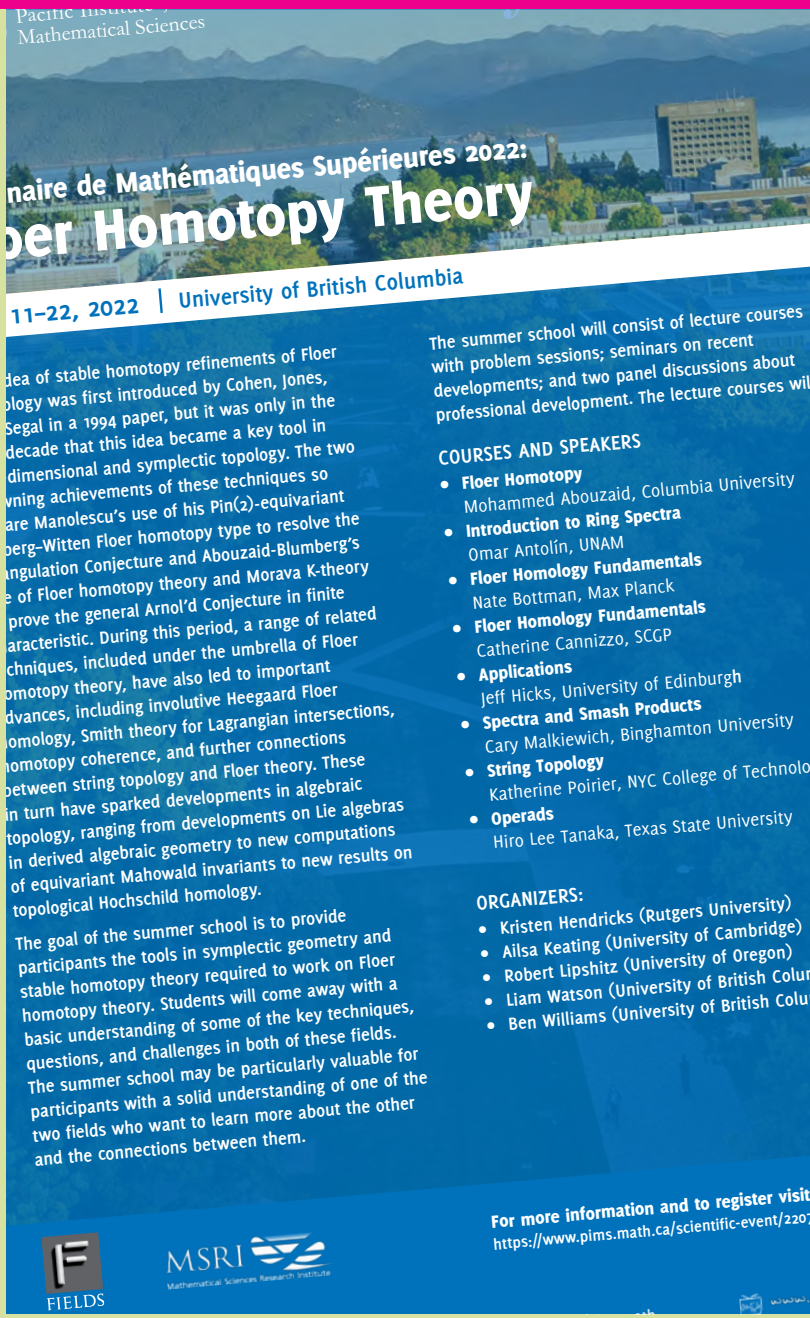
*The 61st edition of the **Séminaire de mathématiques supérieures** was hosted by the **PIMS** in Vancouver on July 11-22, 2022, and was organized by **Ailsa Keating** (Cambridge University), **Kristen Hendricks** (Rutgers University), **Robert Lipshitz** (University of Oregon), **Liam Watson** (University of British Columbia) and **Ben Williams** (University of British Columbia). After two years of virtual SMS due to the pandemic, it was finally possible to go back to the in-person format.*

The summer school featured 6 mini-courses given by some of the world leaders in algebraic and symplectic topology as well as by more junior researchers. The advanced minicourses were 3-4 hours long, while the introductory minicourses were 7-9 hours long. The topics included Floer homology and homotopy, operads and spectra, string topology, spectra and smash products. The mini-courses were accompanied by daily problem sessions, which were greatly appreciated by the participants, as well as "hot-topic" lectures on the important recent advances in the subject. The scientific program of the school was complemented by two discussion panels on topics that are of major significance to young researchers, such as career paths and work-life balance in academia.

The school was attended by more than 60 participants. It was a diverse group of junior mathematicians from different parts of the world. Judging by the participants' feedback, the SMS 2022 was an overwhelming success. Apart from the lectures, talks and problem sessions, the students have really appreciated the possibility to interact with peers, which was particularly valuable after two years of the pandemic.

*Séminaire de mathématiques supérieures would like to thank the organizers of the SMS 2022 for their hard work that made this success possible. We are also grateful to PIMS and its staff for hosting the event and providing the technical assistance. The SMS acknowledges the continuous financial and logistical support of the **CRM**, **Fields Institute**, **PIMS**, and **MSRI**, as well as of the **Université de Montréal**. I would like to thank all these institutions for their contributions. I would also like to express my gratitude to the members of the SMS steering board for their work and dedication.*

***Iosif Polterovich**, Director,*
Séminaire de mathématiques supérieures



A Celebration of Women in Analysis in Canada

March 8, 2022

Online workshop

Organizers: *Linan Chen (McGill University), Rustum Choksi (McGill University), Alexandre Girouard (Université Laval)*

This workshop, which took place on International Women's Day, was designed as a celebration of the exceptional careers of four women analysts in the Canadian mathematical community.

Talks

Christiane Rousseau
(Université de Montréal)

Le problème de l'équivalence en dynamique analytique

Un problème central en dynamique locale est le problème de l'équivalence : quand deux systèmes analytiques sont-ils localement équivalents sous un changement analytique de coordonnées ? Au voisinage d'un point singulier, les représentants des classes d'équivalence pourraient être donnés par des formes normales. Mais, le plus souvent, les changements de coordonnés vers la forme normale divergent. Pourquoi ? Qu'est-ce que cela signifie ? Le déploiement des singularités révèle les obstructions géométriques à la convergence vers la forme normale. Dans cet exposé, nous discutons d'une classe de singularités et de leurs déploiements pour lesquels nous pouvons fournir des espaces de modules pour les problèmes d'équivalence. Nous expliquons les caractéristiques géométriques communes de ces singularités, et comment l'étude du déploiement de ces singularités permet de comprendre à la fois les singularités elles-mêmes, et les obstructions à l'existence de changements analytiques de coordonnées vers la forme normale.

Almut Burchard
(University of Toronto)

What is the best shape? Isodiametric problems arising in aggregation models

How do pair interactions shape the large-scale behaviour of a cloud of particles (animals, social agents ...)? In the most basic models, the shape of the cloud is determined by minimizing an attractive-repulsive interaction energy under suitable geometric constraints. When can we expect aggregation to occur? what is the shape of the resulting flock? I will describe recent work on isodiametric capacitor problems that occur as limiting cases.

Alina Stancu
(Concordia University)

Why hyperbolic space disobeys social distancing

The fundamental gap conjecture has been proved a few years ago after quite some time. It states that for any compact convex domain Ω in R^n, with diameter D, the difference between the first two eigenvalues of the Dirichlet Laplacian on Ω (called the fundamental gap) satisfies the inequality $(\lambda_2 - \lambda_1)D^2 \geq 3\pi^2$. Soon afterwards, the exact same inequality was shown for convex domains on the sphere Sn. Naturally, people inquired about the fundamental gap on the remaining space of constant curvature, the hyperbolic space H^n.

In work with collaborators, T. Bourni, J. Clutterbuck, X.H. Nguyen, G. Wei and V.M. Wheeler, we have shown that for any diameter D, there exists a compact convex domain in H^n with diameter D for which the fundamental gap can be made arbitrarily small, hence ignoring distancing. I will outline the history of the problem, focusing on the similarities and differences between its features on Euclidean and hyperbolic spaces with the aim of giving an intuitive idea of why the fundamental gap conjecture fails in H^n. In the process, I will also touch on different notions of convexity in the hyperbolic space.

Malabika Pramanik
(University of British Columbia)

Progress on progressions

We meet systems of homogeneous linear equations in high school algebra. They are especially easy to solve when there are more variables than equations. Infinitely many solutions! ... or so we are told. This talk aims to provide a counterpoint. Depending on what equation one is solving or where one is looking for solutions, one may find some, plenty, or none. We will explore the simplest geometric example of such an under-determined linear system, a k-term arithmetic progression, given by (k − 2) equations in k unknowns:

$$x_{i+1} - 2x_i + x_{i-1} = 0,\ 2 \le i \le k-1.$$

This example has a long and diverse history, with connections to several areas of analysis, number theory, combinatorics, and geometry. We will look at some of the landmark results in the subject and work out a couple of elementary proofs in real time.

This talk is intended for a general audience. No specialized knowledge will be assumed. Curiosity is a plus!

Appel à propositions

Afin de célébrer et de soutenir les principes d'équité, de diversité et d'inclusion (EDI) dans la communauté mathématique, le CRM lance un appel à propositions pour des activités (ateliers, symposiums, conférences) liées à l'EDI dans les sciences mathématiques. Une liste d'activités EDI récentes organisées par des membres du CRM peut être consultée ici : http://www.crm.umontreal.ca/edi/fr/view/activite.php.

Les demandes doivent inclure un titre et une description de l'activité proposée, les CV de chaque membre du comité organisateur et un budget préliminaire. Les propositions doivent être envoyées à : projets@crm.umontreal.ca.

Call for Proposals

To celebrate and support equity, diversity and inclusion (EDI) principles in the mathematical community, the CRM invites applications for activities (workshops, symposiums, conferences) related to EDI in mathematical sciences. A list of recent EDI activities organized by CRM members can be found here: http://www.crm.umontreal.ca/edi/en/view/activite_e.php

Applications should include a title and description of the proposed activity, C.V.s of each member of the organizing committee, and a preliminary budget. Submissions should be sent to: projets@crm.umontreal.ca.

EDI-COLLOQUIUM ON INDIGENOUS PEOPLE NATIONAL DAY

Dr. Melania Alvarez *(UBC)*

Narrowing the Gap: Addressing Mathematical Inequity in Indigenous Education

Date: *21/06/2021*

Organizers: *Rustum Choksi (McGill University), Alina Stancu (Concordia University)*

Dr. Melania Alvarez is a very accomplished mathematics educator with extensive experience working with Indigenous students. Dr. Alvarez has a broad background in mathematical sciences, mathematics education and beyond. Besides undergraduate studies in actuarial mathematics, she holds Master degrees in operations research, in economics and in anthropology, and a PhD in mathematics education. She assumed in 2005 a joint appointment as BC Education Coordinator at the Pacific Institute for the Mathematical Sciences and as Outreach Coordinator for the UBC Mathematics Department. From these positions, Dr. Alvarez has made a profound impact on the Canadian mathematics education at all levels by organizing workshops for students, teachers, mentorship programs, homework clubs and a variety of math competitions and other events.

Dr. Alvarez is also the 2012 recipient of the Canadian Mathematical Society's prize Adrien Pouliot for which the selection committee was particularly impressed by her work with the Aboriginal community, principally in British Columbia, but also in Alberta and Saskatchewan.

In her talk that was of a very colloquial nature, Dr. Alvarez took us through her work with Indigenous people starting with the need to acknowledge cultural differences, build partnership with the elders and specific communities, as well as to establish long-term interaction for change to occur. Along the years, her work grew into a variety of activities, most notably: math summer camps, math teacher enhancement programs and academic programs during university years, as well as mentorship at all stages. Dr. Alvarez spoke about funding and challenges for programs addressing academic achievement among Indigenous students, and specifics of her activities such as number of people involved, daily schedule, goals and modalities to accomplish them.

At the end of her presentation, Dr. Alvarez answered several questions, some about starting and developing similar activities in Québec.

CWiMAC 2021: Connecting Women in Mathematics Across Canada

June 2-3, 2021

Organizers:

Lucy Campbell *(Carleton University)*

Ailana Fraser *(University of British Columbia)*

Matilde Lalín *(Université de Montréal)*

Karen Meagher *(University of Regina)*

Lucia Moura *(University of Ottawa)*

The CWiMAC workshops have been developed and organized at the initiative of the Committee for Women in Mathematics of the Canadian Mathematical Society. The purpose of these workshops is to support the career development of junior women academics in the Canadian mathematics community. These events have been highly successful in the past. This instance was planned for June 2020, but was postponed to June 2021 and held online, due to the COVID-19 pandemic.

The workshop was targeted at female-identified mathematicians. (We use an inclusive definition of woman and female and we welcome trans women, genderqueer women, and non-binary people who are significantly female-identified.) It was held online on June 2 and 3, immediately preceding the 75th+1 Anniversary Meeting of the Canadian Mathematical Society. The goal of this event was to provide female- identified researchers in mathematics skills to help them succeed, to ensure their continued success and retention in mathematics. We focused on career development and networking. Holding this event directly before the CMS meeting helped the participants to get the most out of the CMS meeting.

The organized activities were held on Zoom, with more informal discussions and virtual coffee breaks held on Gather.town.

Workshop Events

The workshop consisted of a mix of invited presentations, panel discussions, and short research presentations by junior participants.

Summary of Presentations:

- ***Anita Layton***
  Canada 150 Research Chair in Mathematical Biology and Medicine, Applied Mathematics University of Waterloo.

  Prof. Layton is an internationally recognized applied mathematician who uses methods from computational mathematics and partial differential equations to model kidney function. She gave a comprehensive presentation about how to do an elevator speech and network at a conference. Participants learned useful strategies and common mistakes, discussed examples, and were given the opportunity to practise their speeches and get useful and constructive feedback in small groups in zoom breakout rooms. This was very effective as a first event, since people were able to introduce themselves in small groups and meet with other participants. We made sure to have at least one organizer in each Zoom Room.

  This session had 44 participants

- ***Alexandra McSween***
  President of the AWM student chapter and Women in Math Club
  Mathematics and Statistics, University of Ottawa.

  McSween, an MSc student in Mathematics at the University of Ottawa, gave a thought-provoking presentation on the history of women in Math. Her presentation started by discussing historical women in mathematics. She also reflected on what it means for women in mathematics to be held as role models and how we can change the way we think of women in mathematics so that it is more productive and constructive. Particularly thinking about those of us who do not achieve historical recognition! Following the presentation there was a lively discussion of these issues on zoom, which continued in a more relaxed and casual setting on gather.town.

  This session had 41 participants.

- ***Gerda de Vries***
  Mathematical and Statistical Sciences, University of Alberta.

  Prof. de Vries' research interests include dynamical systems and mathematical physiology. She explained to students how to give effective presentations. Prof. de Vries started by showing some common mistakes on presentations (such as overloading slides with details, losing the audience with notation, etc). She also discussed the structure of presentations in terms of giving a good setting (which includes scientific motivation, historical context, relationship with other research, etc), plot (which includes the goal of the presentation, the results, and the conclusions), and characters (which includes the notation and the previous and auxiliary results that are used to support the plot). Finally, several tips for improving presentations were discussed, including simplification of details, presentations of graphs and diagrams, use of colours, etc.

  This session had 40 participants

Student Talks

Five students/post-doctoral fellows gave short (15 minute) talks on their research. The number of participants varied between 20 and 30.

1. ***Hermie Monterde,***
   University of Manitoba
   Perfect State Transfer and Generalizations
2. ***Avleen Kaur,***
   University of Manitoba
   A space-time spectral method for the Stokes problem
3. ***Nadia Lafrenière,***
   Dartmouth College
   Combinatorial study of the convergence to stationary for card shuffling
4. ***Mahsa N. Shriazi,***
   University of Regina
   The Erdős-Ko-Rado theorem for set-wise 2 and 3-intersecting perfect matchings
5. ***Neha Joshi,***
   University of Regina
   Fusion primitivity for Multiplicity-free subgroups of Symmetric groups

Each student was awarded a $150 prize.

Panels:

A. Taking Your Career to the Next Step

The panelists were:

- ***Chantal David,***
  Mathematics and Statistics, Concordia University.
- ***Megan Dewar,***
  Tutte Institute for Mathematics and Computing.
- ***Jessica Lin,***
  Canada Research Chair in Partial Differential Equations and Probability (NSERC) Tier 2, Mathematics and Statistics, McGill University.
- ***Alina Stancu,***
  Mathematics and Statistics, Concordia University.

This panel discussed different career paths in academia and industry, advice about writing research articles and about doing research in general, and useful skills for being a successful mathematician. The panelists also shared some mistakes they had made in the past. There was some additional discussion prompted by audience questions regarding balancing a career as a mathematician and having a family, about securing postdoctoral positions and their relevance as a step before a tenure-track position, and careers as teaching-focused faculty.

Many other topics were covered, including the following:

- *The importance of having collaborators.*
- *That it is okay to not follow the typical career path.*
- *That jobs in industry do not typically require all the skills that you learn in the PhD.*
- *Learning to code and having coding experience will make it easier to move to an industry job.*
- *The importance of making choices thinking about oneself as a whole person, not just a mathematician, and of not being hard on oneself.*
- *Understanding that having children is like having another job and accepting help.*
- *That branching out to other areas of research can be helpful and enrich one's research perspective.*
- *Going to seminars is useful even if you think you will not understand.*
- *Focus on doing meaningful big service that gets noticed may be a more useful time investment than doing many small service assignments that are not noticed and are not meaningful.*

This panel had 49 participants.

B. Building Resiliency and Outlasting Covid

The panelists were:

- ***Barbara Csima,***
  Pure Mathematics, University of Waterloo.
- ***Sara Faridi,***
  Mathematics and Statistics, Dalhousie University.
- ***Malabika Pramanik,***
  Mathematics, University of British Columbia, and Director, BIRS.

This panel discussed the various challenges as well as some positive aspects arising from the pandemic. The focus started around established researchers (such as the panelists), but later shifted to the audience, and several students and postdocs shared their own experiences.

Advantages: The move to on-line venues have given many of us the opportunity to participate in virtual seminars and conferences, the fact that some administrative meetings are improved when held remotely, the opportunity to save the time from commuting, the occasion to reflect on how much we normally travel for conferences and ways to reduce this travelling, the opportunity to spend more time with family.

Challenges: professors: negotiating time and space with family can be difficult, lack of boundaries between life and work, closed schools forcing kids to stay home and do virtual schooling.

Students: feelings of isolation, specially for those starting graduate school, difficulty to secure postdoctoral and permanent positions.

Tips: Jogging, admit that you can't always focus, teach others to help (such as kids), enjoy time with family, take breaks, use the opportunity to learn new skills.

How can institutions help: Be patient, allow for faculty to repeat the courses they teach, teaching reductions, accommodation for caregivers.

How can professors help students: hold regular meetings (both individually and in group), being interested in student's well-being, listening, remember that students are generally facing more challenges, including financial insecurity, job insecurity, etc.

THE TENTH ANNUAL CANADIAN STATISTICS STUDENT CONFERENCE

CCÉS – CSSC

The 2022 CSSC was a great success! *We received positive feedback from participants throughout the day, from professors who attended the event, and in our post-conference survey. Throughout the day, over 125 people joined the conference. Students had a good chance to network, learn a new skill, and share their research. This is thanks to this year's committee members: Victoire Michal & Robyn Ritchie (co-chairs), Renny Doig, Trevor Thomson, Roxane Turcotte, Luke Hagar, Zheng Yu, Faith Lee, Yunhong Lyu, Nikola Surjanovic, My Duc Tran, Henry Ratul Halder, Kyle McRae, Vanessa McNealis, Julien St-Pierre, and Larry Dong.*

The Tenth Annual Canadian Statistics Student Conference

The conference was held on May 28th, 2022 via Zoom. Below is a detailed description of the events of the day. All sessions were delivered live by the speakers.

Student oral and poster presentations

*There were **28 student talks** (3 undergraduates, 13 Master's students, 12 PhD students) and **16 student posters** (4 of each degree level). The best oral and poster presentations were awarded prizes. Given the bilingual nature of the conference, students had the option to deliver their talk in French, English or give a bilingual talk.*

Skills Session

*The skills session was offered by **Ian Bercovitz,** who is the Director of Statistical Consulting Service in the Department of Statistics and Actuarial Science at Simon Fraser University. Mr. Bercovitz delivered a presentation on communication in science and highlighted the importance of communicating to those with or without a strong statistical background.*

Scientific Workshop

*The scientific workshop session was offered by **Dr. John Braun,** Department head and professor in the Department of Computer Science, Mathematics, Physics and Statistics at the University of British Columbia Okanagan Campus. In the session, Dr. Braun reviewed his tips on how to build an R package.*

Keynote Speaker

*Our keynote speaker was **Dr. Lisa Lix,** Professor and associate head of the Max Rady College of Medicine Community Health Sciences at the University of Manitoba. Dr. Lix discussed the types of administrative and clinical data in healthcare and the importance of linked data.*

Career session

*This year's career panelists were **Paul Gustafson** (Professor and Head of the Department of Statistics at the University of British Columbia), **Catherine Njue** (manager for the Office of Biostatistics in the Biologic and Radiopharmaceutical Drugs Directorate (BRDD), Health Canada), and **Francisco Rius** (lead of the data science and data engineering efforts for Minecraft).*

Social activities

Throughout the day, we encouraged participation and avoided Zoom fatigue with a networking lunch (ice-breaker questions and a "Meet-a-PhD" session where undergraduates & Master's students could ask questions about different universities represented by PhD students we had invited), a Stat Bingo, small contests and a trivia night carried out on Kahoot!.

Victoire Michal** and **Robyn Ritchie

Congrès canadien des étudiant·e·s en mathématiques (CCÉM)

13 - 17 juillet 2022

Crédit photos: Philippe-André Luneau

Plus de 150 étudiants du Canada et d'ailleurs se sont rassemblés à l'Université Laval à Québec du 13 au 17 juillet pour participer au Congrès canadien des étudiant·e·s en mathématiques (CCÉM). Cette édition 2022 du CCÉM a été un gros succès, voyant une augmentation de plus de 50% de participation depuis la dernière édition en personne du CCÉM en 2019 et établissant une année record. Il y avait 161 participants, dont 75 qui ont donné une présentation et 8 qui ont présenté une affiche. Ils étaient composés de 109 hommes et 35 femmes, 1 étudiant non-binaire, et 15 qui ont préféré ne pas répondre. Il s'agissait d'étudiants au baccalauréat (130), étudiants gradués (10), postdocs (2), autres (8), et de gens qui ont préféré ne pas répondre. 158 étaient du Canada, 2 des États-Unis et 1 de Chine. Le détail par région est le suivant : 101 étaient de l'Ontario, 36 du Québec, 8 de l'Alberta, 4 de la Colombie-Britannique, 1 du Manitoba, 1 du Nouveau-Brunswick et 1 de la Nouvelle-Écosse (certains n'ont pas répondu).

On avait aussi 6 conférenciers et conférencières d'honneur :

- ***Maxime Fortier-Bourque*** (Université de Montréal, géométrie spectrale et différentielle) ;
- ***Monica Nevins*** (Université d'Ottawa, algèbre) ;
- ***Kumar Murty*** (Université de Toronto, théorie des nombres) ;
- ***William Ross*** (University of Richmond, Analyse) ;
- ***Linan Chen*** (Université McGill, probabilité) ;
- ***Guy Lacroix*** (Université Laval, économétrie et apprentissage automatique).

Il y a eu plusieurs ateliers et activités sociales durant la semaine. On a été en mesure de mettre en place certaines de ces activités, ainsi que d'offrir tous les repas principaux et les pauses-café pendant la semaine, grâce à nos généreux commanditaires.

Pour conclure, on est certain que les mathématiques au Canada ont un bel avenir devant elles grâce à tous ces jeunes esprits brillants !

L'équipe du CCÉM 2022

William Verreault (Président), Ludovick Bouthat, Anthony Doyon, Philippe Drouin, Charlotte Lavoie-Bel, Philippe-André Luneau, Philippe Petitclerc et Dominik Richard.

CRM PRIZES 2021-2022

CRM-Fields-PIMS Prize

The CRM-Fields-PIMS prize is the premier Canadian award for research achievements in the mathematical sciences. It is awarded jointly by the three Canadian mathematics institutes. The winner receives a monetary award and an invitation to present a lecture at each institute within one year after the award is announced.

The prize recognizes exceptional achievement in the mathematical sciences. It was established by the Centre de recherches mathématiques (CRM) and The Fields Institute as the CRM-Fields prize in 1994.

In 2005, the Pacific Institute for the Mathematical Sciences (PIMS) became an equal partner in awarding the prize. The name changed to the CRM-Fields-PIMS prize, the award level increased, and the terms of reference were revised. The winner is selected by a committee appointed by the three institutes.

© Richard Poissant

2022 CRM-Fields-PIMS Prize awarded to

Bálint Virág

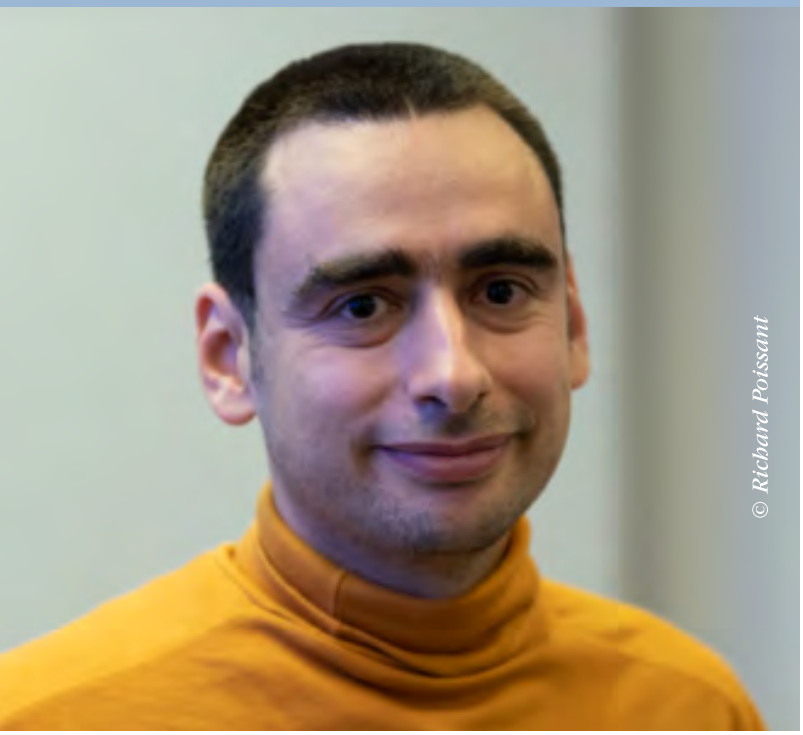
We are pleased to announce that the 2022 CRM-Fields-PIMS Prize was awarded to Bálint Virág, of the University of Toronto. The price is awarded for his exceptional contributions to mathematical research, in the area of probability.

Virág earned his PhD at the University of California, Berkeley in 2000, after which he was a Moore Instructor at the Massachusetts Institute of Technology, before going to the University of Toronto in 2003 as a Canada Research Chair. He has been awarded the Rollo Davidson Prize in Probability, the Coxeter-James Prize in 2010 and the John L. Synge Award from the Royal Society of Canada in 2014. Virág was a speaker at the International Congress of Mathematicians in 2014. Virág's research spans a wide range of areas of probability, including random matrix theory, Kardar-Parisi-Zhang (KPZ) universality, and random sorting networks. Virág has an outstanding record of training students and postdoctoral fellows. Many of them have been gone on to become leaders in probability in their own right.

The CRM-Fields-PIMS prize is the premier Canadian award for research achievements in the mathematical sciences. It is awarded jointly by the three largest Canadian mathematics institutes: the Centre de Recherches Mathématiques (CRM) in Montreal, the Fields Institute in Toronto, and the Pacific Institute for the Mathematical Sciences (PIMS) in Vancouver.

André Aisenstadt Prize

Created in 1991, the André Aisenstadt Prize in Mathematics, which includes a scholarship and a medal, recognizes outstanding research results in pure or applied mathematics by a young Canadian mathematician.



© Richard Poissant

2022 André Aisenstadt Prize awarded to

Yevgeny Liokumovich

University of Toronto

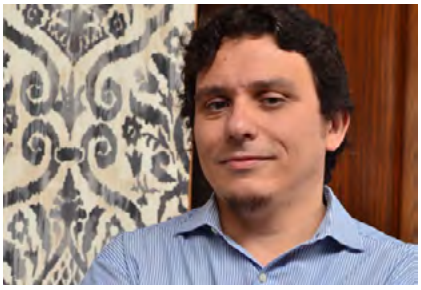
Professor Liokumovich obtained his PhD in 2015 at the University of Toronto under the supervision of Alex Nabutovsky and Regina Rotman. After several postdoctoral fellowships at top institutions in his area — Imperial College of London, MIT and IAS, he returned to a tenure-track Assistant Professorship at the University of Toronto in 2019. His research interests are centered in geometric analysis. Professor Liokumovich was one of the two 2020 Nirenberg lecturers in geometric analysis at the CRM, and he was awarded a Sloan Fellowship in 2021.

For an exposition of his work, see Professor's Liokumovich's article on ***p. 34.***

2021 André Aisenstadt Prize in Mathematics Recipients:

Giulio Tiozzo

University of Toronto



Giulio Tiozzo is an Assistant Professor of Mathematics at the University of Toronto.

He obtained his PhD from Harvard in 2013, under the supervision of C.T. McMullen. Prior to joining the University of Toronto, he was a Gibbs Assistant Professor at Yale University, and in 2018 he was awarded the Alfred P. Sloan Fellowship. His field of research is dynamical systems and ergodic theory, with applications to complex analysis, probability, and geometric group theory.

Tristan C. Collins

Massachusetts Institute of Technology

Tristan Collins is an Assistant Professor in the Mathematics Department at MIT. Formerly he was a Benjamin Peirce Assistant Professor at Harvard University. He studied mathematics at the University of British Columbia, where he worked with Malabika Pramanik. He then obtained his PhD under the supervision of D. H. Phong at Columbia University. His research is in the areas of geometry and analysis, in particular geometric flows, as well as applications of algebraic geometry to analysis and vice versa. He was awarded a Sloan Fellowship in 2018.

CAP-CRM Prize

The Centre de recherches mathématiques (CRM) and the Canadian Association of Physicists (CAP) created in 1995, on the occasion of the 50th anniversary of the CAP, a joint prize in recognition of exceptional achievements in theoretical and mathematical physics.

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 and Institutional 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.

The objective of this award is to recognize research excellence in the fields of theoretical and mathematical physics. The award is not limited to CAP members but the candidates' research should have been done in Canada or in affiliation with a Canadian university or industry. This medal was awarded for the first time at the 1995 CAP Annual Congress.

Le Prix ACP-CRM de physique théorique et mathématique 2021 décerné à

Robert Raussendorf

L'Association canadienne des physiciens et physiciennes (ACP) et le Centre de recherches mathématiques (CRM) sont fiers d'annoncer que le Prix ACP-CRM de physique théorique et mathématique 2021 est décerné à Robert Raussendorf, Université de la Colombie-Britannique, en reconnaissance de ses contributions éminentes à la théorie de l'informatique quantique, notamment ses travaux novateurs sur l'informatique quantique basée sur les mesures ou "à sens unique", l'informatique quantique insensible aux défaillances et les phases de la matière quantique numériquement universelles.

Le professeur Raussendorf a apporté de multiples contributions fondamentales à la théorie du calcul quantique. Il a proposé une nouvelle technique, l'ordinateur quantique "à sens unique" ou basé sur les mesures, qui est considérée comme l'une des rares voies viables pour les ordinateurs quantiques physiques. Il a développé un schéma pour le calcul quantique insensible aux défaillances et a identifié une phase de la matière quantique numériquement universelle.

Le calcul quantique basé sur les mesures implique la préparation d'un état de ressource à plusieurs qubits intriqués, puis l'exécution de mesures locales spécifiées par le calcul souhaité. Cette proposition a donné lieu à de nombreuses preuves de principe expérimentales et est actuellement à l'origine des efforts d'au moins deux entreprises qui tentent de fabriquer des ordinateurs quantiques fonctionnels.

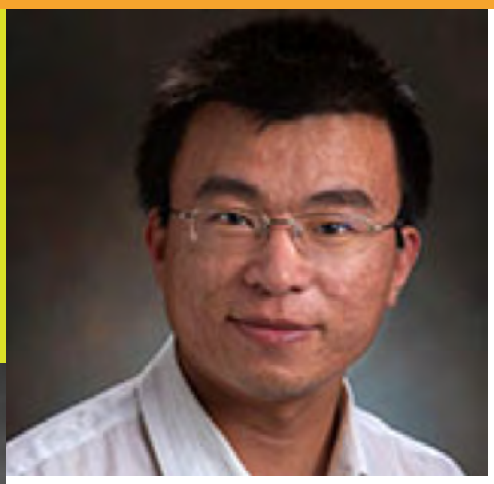
Afin d'établir un lien plus étroit avec les circuits pratiques, le professeur Raussendorf a étudié les états en grappe et a montré qu'ils pouvaient être réalisés dans un réseau bidimensionnel en utilisant uniquement des mesures locales et de proximité. En outre, ils peuvent être configurés pour permettre un calcul quantique insensible aux défaillances. Cette idée est considérée comme l'une des approches les plus prometteuses de l'informatique quantique réaliste à grande échelle et insensible aux défaillances.

Récemment, Robert a exploré les phases de calcul de la matière quantique, en exploitant certaines phases topologiques pour le calcul. Il a identifié une phase de système de spin à deux dimensions qui est universelle sur le plan informatique. Il a proposé une technique de simulation classique pour les systèmes à dimension finie avec des états magiques sur les qubits. Dans un travail connexe, il a montré qu'un système statistique classique, et les manipulations de ce système, peuvent être utilisés pour simuler un ensemble universel d'opérations quantiques. Ce lien étroit entre les calculs quantiques et les statistiques classiques suscite un vif intérêt.

M. Raussendorf dirige le Quantum Computing Grand Challenge financé par le Stewart Blusson Quantum Matter Institute de l'Université de Colombie-Britannique.

CRM-SSC Prize

The CRM-SSC Prize in Statistics is awarded annually by the Centre de recherches mathématiques (CRM) and the Statistical Society of Canada (SSC) in recognition of a statistical scientist's professional accomplishments in research during the first fifteen years after having received a doctorate.

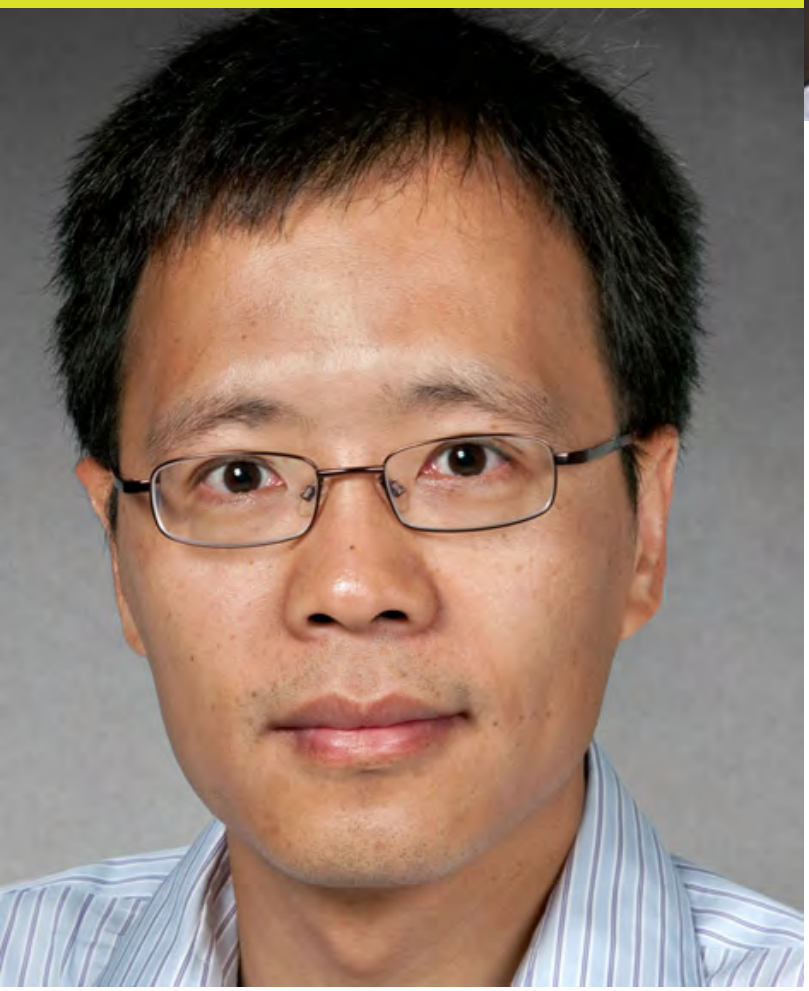


2021 CRM-SSC Prize Recipient:

Jiguo Cao

Simon Fraser University

Jiguo Cao, Professor and Canada Research Chair in the Department of Statistics and Actuarial Science at Simon Fraser University, was awarded the prize for outstanding developments in modeling and analysis of functional data and dynamic systems; for broad work in numerous applications with special focus on statistical genetics; and for remarkable aptitude for creating and nurturing productive collaborations, particularly involving students and post-doctoral fellows.



The 2022 CRM-SSC Prize awarded to

Pengfei Li

University of Waterloo

Pengfei Li was awarded the CRM-SSC prize in statistics for ground-breaking and pioneering research contributions to the EM-test for the order of finite mixture models; for original and creative methodological developments in the areas of the empirical likelihood, density ratio models, statistical genetics, non-probability sampling; for exceptional research productivity; and excellence in statistical education.

THE WORK OF THE 2022 ANDRE AISENSTADT PRIZE WINNER

Yevgeny Liokumovich

1. Morse Theory on the Space of Cycles

Given a space X and a function $F : X \to \mathbb{R}$, how do we find critical points of F? One way would be to start with a random point on X and move in the direction of $-\nabla F$ until we get to a local minimum of F. But this way we won't be able to find critical points that are not local minima, and for some problems local minima do not exist or aren't very interesting.

A powerful idea that goes back to Birkhoff, Lusternik, Schnirelmann and Morse, is that we can exploit the topology of X to find saddle points of F. Instead of pushing one point along $-\nabla F$ we consider a topologically non-trivial family of points $\{z_t\}$ and deform this family continuously to minimize $\max_t F(z_t)$. Since the family is non-contractible, it will get "stuck" somewhere, and the point where it gets "stuck" is the critical point we are looking for.

One can also use the following analogy. Say a group of tourists wants to get to the other side of a mountain range in the easiest possible way. They are not interested in climbing the peak of a mountain in the range, rather they want to find a mountain pass. The problem of finding a mountain pass can also be described as finding a path with the smallest possible maximum elevation among all paths connecting two points on the two sides of the range. In other words, we are trying to minimize a maximum. Terrain around this min-max point will look like a saddle and it will be a critical point of the height function.

This idea was used by Birkhoff to prove existence of a closed geodesic on any Riemannian 2-sphere (taking X to be the free loop space on the sphere and F the energy functional). Lusternik and Schnirelmann strengthened this result to prove existence of three distinct simple closed geodesics. In the 1980s, Sacks and Uhlenbeck proved existence of branched minimal immersions of Riemann surfaces in a Riemannian manifold. But problems arise if one considers the space of maps from a manifold of dimension higher than 2. As was shown by White, the minimization process may lead to a map degenerating, so that its image clusters towards a minimal submanifold of different topology than the domain. To find embedded minimal submanifolds of higher dimension we need to consider a space with more exibility, one that allows the topology of the submanifolds to change.

In the 1960s, Almgren initiated a program for developing a Morse theory on such a space, the space of k-dimensional flat cycles. This space was first introduced by Federer and Fleming to study the Plateau problem. The elements of this space can be thought of as Lipschitz polyhedral chains with 0 boundary. Two such cycles, z_1 and z_2, are close to each other in at topology if their dierence $z_1 - z_2$ is the boundary of some $(k + 1)$-dimensional Lipschitz chain of small volume. Almgren determined the homotopy type of the space of at cycles and showed that for each non-trivial homology class of the space of k-cycles there exists a certain generalized minimal submanifold, a k-dimensional stationary integral varifold. But the path from these generalized singular minimal submanifolds to a smooth embedded minimal submanifold turned out to be a

difficult one. It was only in the 1980s that Pitts, using curvature estimates for stable minimal hypersurfaces of Schoen and Simon, built on the work of Almgren to show that every closed manifold M^n, $3 \leq n \leq 7$, contains a smooth minimal hypersurface.

A decade ago Marques and Neves revived interest in Almgren-Pitts Min-Max Theory, using it to resolve many long-standing open problems. One particular aspect that emerged is that understanding the topology of the space of cycles from a quantitative point of view leads to new results about minimal submanifolds.

2. Weyl Law for the Volume Spectrum.

The space of at k–cycles on a closed manifold with $\mathbb{Z}_2$ coecients has a non-trivial cohomology element λ, such that all of its cup powers are also non-trivial. Hence, to each cohomology class λ^p we can associate the corresponding min-max value ω_p^k for the volume functional, and we expect this value to correspond to the volume of some minimal submanifold. Gromov observed an analogy between the sequence $\{\omega_p^k\}$ and eigenvalues of the Laplacian, which also have min-max characterization in terms of the Rayleigh quotient. Gromov conjectured that many results about the linear spectrum should have a counterpart in the non-linear world of $\{\omega_p^k\}$, the volume spectrum. Specically, he conjectured that there should exist an asymptotic formula for ω_p^k analogous to the asymptotic Weyl law for the eigenvalues of the Laplacian. In a joint work with Marques and Neves the result was proved for codimension one cycles.

Theorem *(L.-Marques-Neves, 2018).*
For any compact Riemannian manifold

$$\lim_{p\to\infty} \frac{\omega_p^{n-1}(M)}{p^{\frac{1}{n}}} = a(n)Vol(M)^{\frac{n-1}{n}}$$

One can think this of this as a result in quantitative topology: for each cohomology class we show existence of an asymptotically optimal representative. In a joint work with Guth we showed that the Weyl law in higher codimensions can be deduced from parametric versions of two famous inequalities: the isoperimetric inequality and coarea inequality. Given a contractible family of cycles $\{z_t\}$ we know, for topological reasons, that there exists a family of $(k + 1)$-chains $\{\tau_t\}$ such that $\partial\tau_t = z_t$. The parametric isoperimetric inequality states that we can make this existence result quantitative: there exists a family $\{\tau_t\}$ with volume controlled by volumes of cycles z_t in a certain precise way. In our work with Guth we proved this parametric inequality in low dimensions, and consequently extended the Weyl law to the case of 1-cycles in 3-manifolds.

3. Applications of Quantitative Topology to Problems in Geometric Analysis

Similarly to the case of the Weyl law for the volume spectrum, quantitative results about the topology of the space of cycles lead to new insights for problems in geometric analysis Theory. In a joint work with Chambers we developed a technique for replacing an arbitrary one-parameter family of cycles with a family that satisfies certain nestedness properties with no volume increase. We used this result to prove existence of minimal hypersurfaces of finite volume in complete non-compact manifolds of finite volume. In joint work with Chodosh and Spolaor, this technique was used to show that singularities of one-parameter min-max minimal hypersurfaces of dimension 7 can be perturbed away (our result was later generalized by Li and Wang to prove existence of inffinitely many smooth minimal hypersurfaces in generic 8-dimensional manifolds).

In the late 1980s, Pitts and Rubinstein proposed that under some natural topological and geometric conditions the min-max procedure applied to a family of surfaces coming from the Heegaard splitting of a 3-manifold will result in an index 1 minimal surface in the same isotopy class. This was proved in a joint work with Ketover and Song, using (among other things) a quantitative version of Alexander's theorem asserting that a smoothly embedded sphere can be isotopically contracted.

Minimal surfaces and methods of quantitative topology have also lead to better understanding of manifolds of positive scalar curvature. In a joint work with Maximo we used min-max constructions to show that every 3-manifold of positive scalar curvature admits a singular foliation by surfaces of controlled area, genus and diameter. In a joint work with Chodosh and Li we used a quantitative result of Alpert-Balitskiy-Guth about manifolds with positive macroscopic scalar curvature to prove topological classication results for 4 and 5-dimensional manifolds that admit positive scalar curvature and have homotopy group $\pi_2 = 0$ (in the case of dimension 4) or $\pi_2 = \pi_3 = 0$ (in dimension 5).

This interplay between topology and geometric analysis will undoubtedly lead to many more breakthroughs.

CRM-ISM Postdoctoral Fellowships

The CRM-ISM Postdoctoral Fellowships are awarded to promising researchers who have recently obtained or expect to obtain a PhD in the mathematical sciences.

2021-2022

Antonio Alfieri

(Central European University)

Geometry and topology

Supervisors: *Steven Boyer, Olivier Collin, Duncan McCoy (UQAM)*

My research is motivated by problems in low-dimensional topology (knot theory, 3- and 4-manifold topology), and algebraic geometry (topological aspects of singularity theory). To study this type of problems I use the tools of Heegaard Floer homology, and instanton Floer homology.

With my collaborators I initiated the study of a variant of involutive Heegaard Floer homology that can be used to study group actions on 3-manifolds. More recently I concentrated on the study of the instanton Floer homology of graph manifolds using the methods of lattice cohomology.

Semen Artamonov

(Rutgers, The State University of New Jersey)

Mathematical physics

Supervisors: *Marco Bertola, John Harnad, Dmitry Korotkin (Concordia)*

Blake Keeler

(University of North Carolina at Chapel Hill)

Mathematical analysis

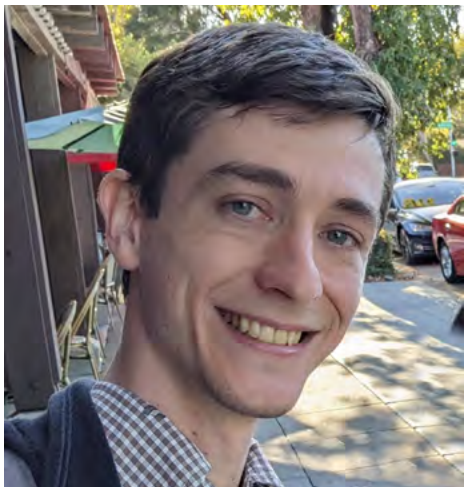
Supervisors: *Dmitry Jakobson, John Toth (McGill), Iosif Polterovich (Montréal)*

Jonathan Love

(Stanford University)

Algebra and number theory

Supervisors: *Henri Darmon, Eyal Goren, Michael Lipnowski (McGill)*



My research is in computational number theory and arithmetic geometry; I study the properties of algebraic structures associated to geometric objects, often using computer assistance. Some structures I have been investigating recently include supersingular isogeny graphs, Chow groups of zero-cycles on surfaces, torsion in the Jacobians of superelliptic curves, spaces of unramified cusp forms on genus 2 function fields, and rational points on families of curves.

Gilles Parez

(UC Louvain)

Mathematical physics

Supervisors: *Yvan Saint-Aubin, Luc Vinet, William Witczak-Krempa (Montréal)*

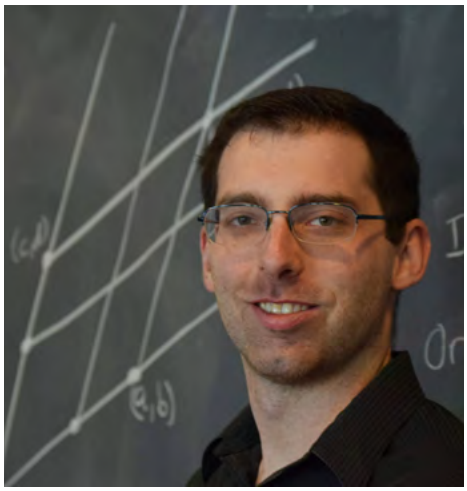
My research lies at the intersection between statistical mechanics, condensed matter and quantum information. In my work, I study what is called quantum entanglement. It is a purely quantum property that has no counterpart in classical mechanics. More specifically, I focus on entanglement properties of quantum many-body system, and their relations to quantum phase transitions and quantum systems out of equilibrium. During my PhD, I studied low-dimensional systems that can be solved exactly, such as integrable spin chain and related statistical models. Currently, my aim is to develop new analytical methods to tackle these questions in the context of quantum systems in higher dimensions and with spatial inhomogeneities.

George Shakan

(University of Illinois at Urbana-Champaign)

Algebra and number theory

Supervisors: *Andrew Granville, Dimitris Koukoulopoulos (Montréal)*



My primary research interests are additive combinatorics, analytic number theory and the intersection of the two. Research has led me to incidence geometry, exponential sums, probability, harmonic analysis, sieve theory, combinatorics, and elsewhere.

Eric Stubley

(University of Chicago)

Algebra and number theory

Supervisors: *Patrick Allen, Henri Darmon, Eyal Goren (McGill)*

Ruiran Sun

(Johannes Gutenberg-Universität)

Geometry and topology

Supervisors: *Julien Keller, Steven Lu (UQAM), Peter Russell (McGill)*

My main research interest is algebraic geometry, especially the geometry of moduli spaces. I take Lang-Vojta's conjecture and Shafarevich's conjecture as the guiding principles of my study of moduli spaces. For example, a classical theorem of A. Borel tells us that any holomorphic map from a complex algebraic variety to a Shimura variety automatically algebraizes. In particular, every Shimura variety has a canonical algebraic structure. In my thesis, I generalize this theorem to moduli spaces of polarized manifolds with semiample canonical sheaf. I'm also interested in Nonabelian Hodge theory and its p-adic analogue.

Anudeep Surendran

(Queensland University of Technology)

Applied mathematics in biosciences and medicine

Supervisor: *Morgan Craig (Montréal)*

My research interests lie in the application of mathematical and computational methods to better understand biological and ecological systems, and make useful insights that are otherwise challenging to obtain solely from experimental and clinical studies. I use various mathematical tools, including ordinary and partial differential equation modelling, stochastic simulations, and agent-based modelling to study processes ranging from gene expression at the cellular level to predator-prey and Allee dynamics at the ecosystem scale. More recently, I am focused on developing optimal treatment strategies for glioblastoma (GBM), one of the most aggressive and deadly brain cancers. These works, based on an agent-based modelling framework, aid in advancing our understanding of immunological interactions in GBM and concretely improving candidate therapies and pre-clinical decision making.

POSTDOCTORAL FELLOWS

CRM-ISM Postdoctoral Fellowships

The CRM-ISM Postdoctoral Fellowships are awarded to promising researchers who have recently obtained or expect to obtain a PhD in the mathematical sciences.

2022-2023

Min Chen

(University of Science and Technology of China)

Geometric Analysis

Supervisors: *Pengfei Guan, Valentino Tosatti, Jérôme Vétois (McGill), Alina Stancu (Concordia)*

My research lies in fully nonlinear geometric PDEs, especially in geometric curvature flows of hypersurfaces. The geometric flow of hypersurfaces is an interesting and active area. Its importance lies in the applications in geometry and topology. My recent work focuses on the application of curvature flows in the proof of geometric inequalities. There is a conjecture proposed by Brendle, Guan, and Li on Alexandrov-Fenchel inequalities for quermassintegrals in the sphere. In one project, by applying two kinds of curvature flows in the sphere, Guan and Li's locally constrained mean curvature type flow and Gerhardt's inverse curvature flow, we make significant progress towards a complete answer to the Conjecture. I am also carrying out several other research projects. Another project is about the Gauss curvature-type flows. We extended the celebrated results on Gauss curvature flow in the Euclidean space by Andrews-Guan-Ni and Brendle-Choi-Daskalopoulos to space form completely.

Serte Donderwinkel

(University of Cambridge)

Probability, Combinatorics and Computational algebra

Supervisors: *Alexander Fribergh (Montréal), Louigi Addario-Berry, Jessica Lin (McGill)*

My research is in discrete probability. I mostly study random graphs from various angles, and the common denominator of my projects is that they involve a 'cute' sampling procedure that allows one to study the properties of the random objects as they grow large. For example, a new discrete line-breaking procedure allowed me and my coauthor to obtain new tail-bounds on the height of random trees, resolving a couple of conjectures from the literature. During my fellowship, I am planning to work on (random) graphs and trees from a variety of perspectives, including enumerative problems, large deviations principles, (metric space) scaling limits and dynamics on graphs.

Joshua Flynn

(University of Connecticut)

Mathematical analysis, Geometry and topology

Supervisors: *Galia Dafni, Alina Stancu (Concordia), Pengfei Guan, Jérôme Vétois (McGill)*

My research interests include analysis on flat and curved geometries (e.g., hyperbolic space and more general symmetric spaces) and noncommutative groups (e.g., the Heisenberg group) using Fourier analysis, geometric analysis and PDE methods. In the past I have worked on establishing sharp geometric inequalities (e.g., the Caffarelli-Kohn-Nirenberg, Hardy-Sobolev-Maz'ya and related inequalities). My current projects include problems in harmonic analysis, geometric flows, nonlinear PDEs and sharp geometric inequalities.

Jakob Hedicke

(Ruhr-Universität Bochum)

Geometry and topology

Supervisors: *François Lalonde, Egor Shelukhin (Montréal)*

My research lies at the intersection between contact/symplectic geometry and Lorentzian geometry.

In particular I study the natural contact and symplectic structures on spaces of geodesics of a Lorentzian manifold and their relation to causality, as well as causal properties of Lorentzian structures that can be defined on groups of contact and symplectic transformations.

Recently I am also working on the existence of Reeb flows with certain integrability properties on contact 3-manifolds.

Valeriya Kovaleva

(University of Oxford)

Number theory, Probability

Supervisors: *Chantal David (Concordia), Andrew Granville, Dimitris Koukoulopoulos (Montréal)*

My research interests lie primarily in analytic number theory and probabilistic number theory. I am particularly interested in drawing connections between number theory and probability theory in a very general sense to understand problems in arithmetic statistics, character sums, and the behaviour of the Riemann zeta function. I like to take inspiration in random matrix theory as it provides a very rich toolbox through its connections to physics, combinatorics, representation theory, group theory, and Gaussian multiplicative chaos. These tools have already led to a number of breakthroughs in the recent years, and I believe that the probabilistic approach will continue to help make progress on long-standing problems, and extend our understanding of existing results.

Michael Roysdon

(Kent State University)

Mathematical analysis, Geometry and topology, Probability

Supervisors: *Alina Stancu (Concordia), Dmitry Jakobson, Pengfei Guan (McGill)*

My research is in Asymptotic Geometric Analysis, a field at the intersection of Convex Geometry, Functional Analysis and Probability. My research often centers around problems which are isoperimetric in nature. Recently, I have been interested in the connection between Harmonic Analysis and Convex Geometry--viewing geometric problems through the lens of integral transforms such as the Radon and Cosine transforms and using properties of these objects to prove geometric and functional inequalities. Of late, I have also been interested in affine invariants inequalities of the Sobolev type, and their connection to isoperimetric problems.

CRM-Simons Postdoctoral Fellowships

As part of its partnership with the Centre de recherches mathématiques (CRM) and in response to the COVID-19 crisis, the Simons Foundation has created the Simons Bridge for Postdoctoral Fellowships to provide additional funding to institutes to support one-year postdoctoral positions in the mathematical sciences. The CRM-Simons Postdoctoral Fellowships are twelve-month appointments and are awarded to exceptional young researchers who have recently obtained or expect to obtain a PhD in the mathematical sciences. This is a research fellowship allowing the recipient to devote most of his or her time to research under the supervision of a professor from one of the CRM member universities.

2021-2022

Clément Berthière

(Université de Tours)

Mathematical physics

Supervisor: *William Witczak-Krempa (Montréal)*

My research interests lie primarily at the interface of quantum many-body physics and quantum information theory. At the heart of my work is the question: "What does quantum entanglement tell us about the structure of quantum states of many-body systems?"

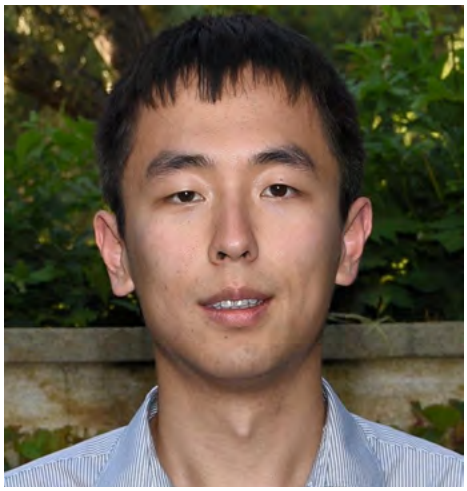
Through the unifying lens of entanglement, my research focus has been on a diverse range of topics including: boundary signatures in critical systems, non-relativistic (Lifshitz) theories, topological systems, separability problem in Rokhsar-Kivelson states, and a host of other topics.

Ruiyuan Chen

(University of Illinois at Urbana-Champaign)

Mathematical logic and Category theory

Supervisors: *Marcin Sabok, Anush Tserunyan (McGill)*



My research lies in mathematical logic, more specifically in descriptive set theory and categorical logic. Descriptive set theory provides a detailed hierarchy of possible complexities of classification problems (e.g., various types of groups). Categorical logic provides algebraic invariants that fully capture everything "definable" in a logical syntax. I'm interested in understanding a duality that has recently emerged between these two areas, as well as connections to geometric and measured group theory, topological dynamics, and topos theory.

Kevin Church

(University of Waterloo)

Applied mathematics

Supervisor: *Jean-Philippe Lessard (McGill)*

My research interests center around the theory and applications of non-smooth dynamical systems and functional differential equations, with my more recent focus being on computer-assisted proofs and validated numerics. The latter combines ideas from functional analysis and approximation theory to render numerical methods that are sufficiently rigorous that they can be used to prove – with the assistance of the computer – periodic orbits, connecting orbits, bifurcations and other structures. In this direction, my current interests are ordinary and impulsive differential equations with state-dependent delay. State-dependent delay results in nested compositional nonlinearity at the level of the vector field, which leads to smoothness issues of the associated semiflow, poor resolution of spectral methods and, consequently, deep subtleties in the validated numerics.

2022-2023

Baptiste Louf

(Université de Paris)

Combinatorics, Probability theory and stochastic processes

Supervisors: *François Bergeron (UQAM), Louigi Addario-Berry (McGill)*

I am broadly interested in the geometry of 2D surfaces. My main object of study is combinatorial maps (discrete surfaces), but I am trying to connect them to other geometric models such as hyperbolic surfaces. My research involves mostly combinatorial tools (algebraic, enumerative and bijective) and discrete probability.

Frédéric Ouimet

(McGill University)

Statistics

Supervisors: *Christian Genest, Erica Moodie (McGill University)*

I was a postdoctoral scholar at Caltech and McGill before joining the CRM.

In the past, I was interested primarily in the extremal properties of branching processes and log-correlated Gaussian (and near-Gaussian) fields, which include the inhomogeneous branching random walk, the inhomogeneous Gaussian free field, and the Riemann zeta function on the critical line when the imaginary part is randomized (and some of its approximations). My current interests lie in mathematical statistics, specifically in asymptotic statistics, multivariate analysis, and nonparametric estimation. More specifically, some subjects that interest me are local limit theorems, comparison of experiments, Bernstein estimators, and asymmetric kernel estimators. For example, I have papers that extend the realm of asymmetric kernel methods to interesting spaces such as the simplex and the space of symmetric positive definite matrices. Other topics that are also of interest to me include the theory of completely monotonic functions and the Gaussian product inequality conjecture.

Anwesh Ray

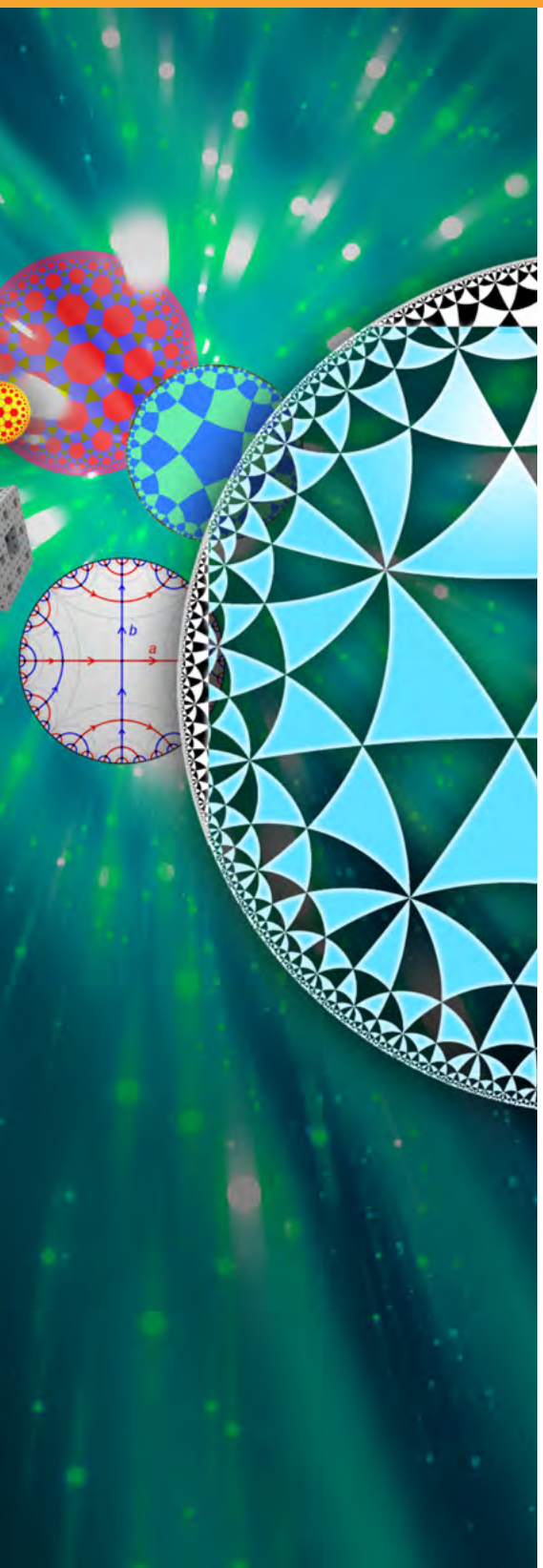
(University of British Columbia)

Algebraic geometry and Number theory

Supervisors: *Matilde Lalín (Montréal), Antonio Lei (Laval)*

I specialize in number theory and arithmetic geometry. My work is primarily in arithmetic statistics, Iwasawa theory and Galois deformation theory.

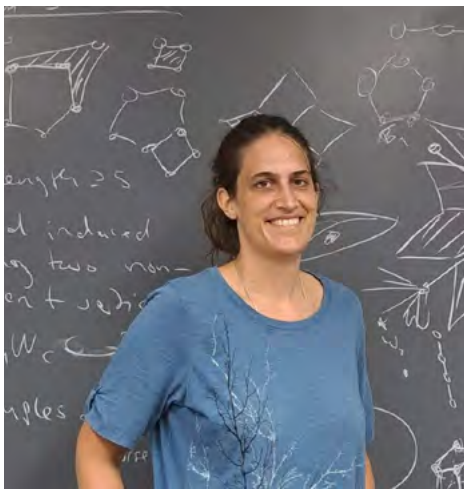
Winter–Spring 2023 Thematic Program Postdoctoral Fellows: Geometric Group Theory



Annette Karrer

(Karlsruher Institut für Technologie)

Supervisors: *Piotr Przytycki, Daniel Wise (McGill)*



My research area is geometric group theory. I investigate the large-scale geometry of finitely generated groups with a focus on non-positively curved groups. My work is related to group theory, topology, graph theory and dynamics and has two main topics: boundaries of groups, and non-positively curved complexes such as CAT(0) cube complexes and systolic complexes.

Harry Petyt

(University of Bristol)

Supervisors: *Piotr Przytycki, Marcin Sabok, Daniel Wise (McGill)*

I work in geometric group theory, with a particular focus on metric nonpositive curvature and generalisations of hyperbolicity for groups. I like to think about how a change of metric on a space can provide new information about groups acting on it.

De nouveaux visages au CRM

Si vous avez eu l'occasion de visiter le CRM ces derniers mois, vous avez probablement croisé de nouveaux visages. En effet, il y a eu quelques changements au niveau du personnel de soutien, et j'aimerais vous présenter les personnes qui se sont jointes à l'équipe.

J'occupe depuis le mois de février le poste de directeur adjoint – administration. Ma principale responsabilité est de m'assurer que l'ensemble des ressources du CRM, humaines, financières et matérielles, supportent ses orientations stratégiques, et de veiller au bon fonctionnement du Centre. Je coordonne le personnel de soutien au quotidien et appuie la direction dans les différents volets de la vie du CRM.

Nous avons la grande chance de continuer de profiter de l'expérience, des connaissances et de la sagesse de Vincent Masciotra, auparavant chef de service et qui occupe maintenant le poste de coordonnateur principal. Il supervise les communications, notamment la refonte du site web, et participe activement aux demandes de subvention ainsi qu'aux suivis avec les organismes subventionnaires, en plus de conseiller régulièrement la direction et l'équipe de gestion financière.

Cette équipe a d'ailleurs une nouvelle capitaine en la personne d'Elena Pukhaeva, qui s'est jointe à nous en juin en tant qu'agente de gestion financière et qui succède à Hernando Naranjo. Elle a pour mandat général de voir à la bonne gestion des finances et s'occupe plus précisément de la planification des dépenses à venir, de la reddition de compte et du suivi des nombreuses demandes de paiement que nous traitons chaque jour. Elle est appuyée depuis septembre par Camila Bazzi Dantas, technicienne en administration et bureautique, qui supervise le traitement de ces demandes.

Nous avons créé un second poste de technicienne au sein de l'équipe d'activités. Marion Cesari est entrée en poste au début janvier, et elle va appuyer Virginie, Sakina et Guillermo dans l'organisation des nombreuses activités du CRM.

Cette équipe est épaulée au quotidien par trois aide-techniques, nos spécialistes Zoom qui veillent au bon déroulement du volet hybride des activités. Il s'agit de Karim El Ghorayeb, Paul Hébert et Mozhgan Moeintaghavi.

Depuis octobre, l'équipe de communication peut également compter sur une nouvelle technicienne en communication et marketing, Paula Rossi, qui publie notre infolettre, anime nos réseaux sociaux et collabore aux différentes publications, dont ce bulletin. Notez que Paula et Camila travaillent toutes deux à mi-temps.

Les recrues sont unanimes : nous avons reçu un accueil exemplaire de la direction et de l'équipe en place, qui nous accompagnent au quotidien et répondent à nos multiples questions, tout en se montrant ouvertes à nos propositions d'amélioration et de développement. Encore une fois, un grand merci!

S'il y a eu de nombreuses arrivées, il y a aussi un départ. Fatou Diouf, qui a épaulé avec brio les équipes d'activités scientifiques et de gestion financière, partageait son temps entre le CRM et le réseau Fin-ML, où elle est retournée à temps plein depuis de janvier 2023. Merci Fatou pour ton appui!

Vous aurez peut-être remarqué l'absence de Flore Lubin, notre technicienne aux activités scientifiques. Rassurez-vous, ce n'est que temporaire! En effet, Flore ayant donné naissance au petit Alexandre, elle est en congé de maternité. Ricardo Briceño a également eu un enfant cet automne : Arthur. Bienvenues aux bébés, et félicitations aux nouveaux parents!

Ce court billet avait pour objectif de vous présenter les nouveaux membres du personnel, et je ne peux malheureusement pas passer en revue l'ensemble de l'équipe et leurs contributions. Je vous invite donc à visiter notre nouveau site web pour connaître la composition complète de l'équipe de soutien : https://www.crmath.ca/a-propos/personnel/.

Benoit Durand-Jodoin
Directeur adjoint - administration

TABLE RONDE DU 7 NOVEMBRE

Quelques notes sur l'état des mathématiques au Québec

© Richard Poissant

Le lundi 7 novembre, le CRM tenait une table ronde, modérée par le directeur du CRM, Octav Cornea, sur l'état des sciences mathématiques au Québec. Les sept panélistes étaient (de gauche à droite) Nathalie de Marcellis-Warin (directrice, CIRANO), Yoshua Bengio (directeur scientifique, Mila), Janice Bailey (directrice scientifique, FRQNT), Alejandro Adem (président, CRSNG), Marie-Josée Hébert (vice-rectrice à la recherche, à la découverte, à la création et à l'innovation, Université de Montréal), Andrew Granville (professeur, Université de Montréal) et Morgan Craig (professeure, Université de Montréal).

Après la présentation par chacun des membres de la table ronde de leur vision des mathématiques au Québec, vision plutôt très positive de l'avis de chacune et chacun, les discussions ont mené bon train. Voici quelques extraits, partiels et certainement partiaux.

A. Granville a rappelé que, trente ans auparavant, la recherche en mathématiques au Québec était de la recherche « en mathématiques pures », et que les chercheurs en mathématiques le font pour « le fun ». A. Adem reprend la parole alors pour rappeler que lui, même comme mathématicien pur (en topologie), n'oubliait pas les applications. Il rappelait à ce propos qu'il fallait suivre en détail certaines tendances actuelles: désormais, on peut démontrer des théorèmes grâce aux ordinateurs (preuves assistées par ordinateurs), et de nombreuses décisions politiques (« policy makers » était le terme exact qu'il a employé) s'appuyaient sur l'expertise en mathématiques. Y. Bengio, quant à lui, souligne que des idées issues des mathématiques ou de la physique étaient désormais utilisées en « computer science ». N de Marcellis soulignait, quant à elle, que les mathématiques étaient de plus en plus utilisées et utiles pour les sciences sociales, en très grande partie suite à l'explosion des données disponibles dans tous les domaines, et elle soulignait l'importance de s'intéresser à la connaissance en mathématiques de la population et de la numératie de cette population. M. Craig souligne l'évolution en mathématiques dans ses relations avec les autres sciences et disciplines, en rappelant qu'elle était elle même une mathématicienne dans un laboratoire de recherche médicale. J. Bailey a rappelé la grande avancée récente des mathématiques dans la dissémination (par l'intermédiaire de l' « open access ») qui, selon elle, est un moteur certain pour la diversité des profils, et pour la possibilité que donne les mathématiques de créer un environnement plus ouvert, en créant des équipes ayant des « backgrounds » différents.

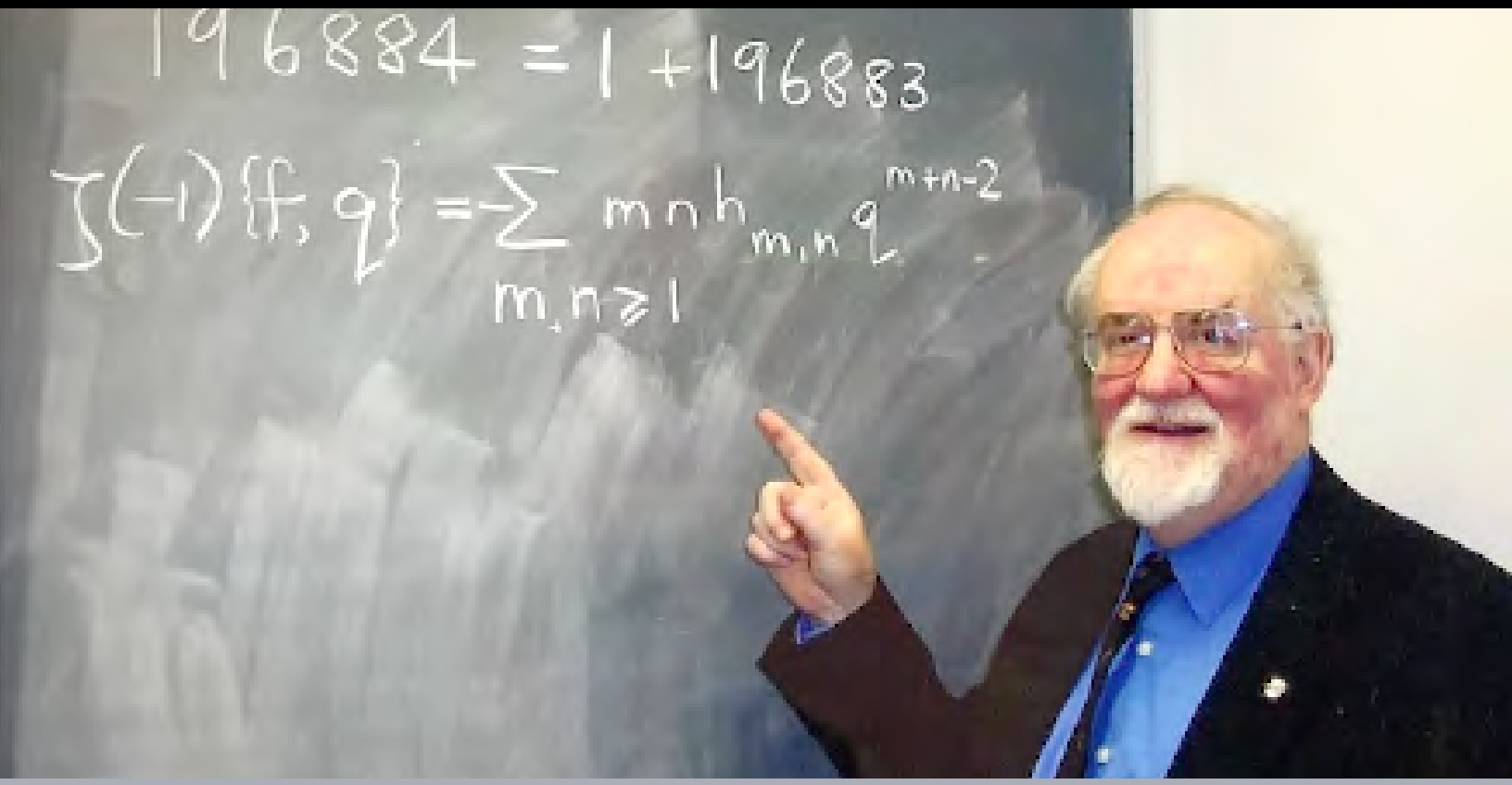
Selon elle, on mésestime un peu le rôle des mathématiques, les mathématiques sont trop invisibles, et la différence entre les mathématiques « sexy » et les mathématiques qui sont en réalité partout est assez importante dans l'imaginaire du public. O. Cornea rappelle que l'impact des mathématiques sur la société est important, que cela soit des mathématiques « pures » comme des mathématiques « appliquées », et, d'ailleurs, à ce propos, il rappelle que la distinction est artificielle et qu'il existe un vrai continuum entre les mathématiques très appliquées et les mathématiques « pures ».

Le débat s'est alors porté sur le manque de formation en mathématiques de base pour les chercheurs d'autres disciplines. M. Craig rappelait que, dans les équipes avec lesquelles elle interagissait (en médecine et en biologie), les médecins eux mêmes soulignaient que les candidats aux postes avaient la bonne formation en biologie, par exemple, mais manquaient d'éléments de formation en mathématiques, et parfois ceux-ci préfèreraient des personnes ayant une meilleure formation en mathématiques même s'ils avaient moins de connaissances en biologie. Y. Bengio a mentionné qu'il était plusieurs fois dans sa vie sorti de sa zone de confort, et que ce simple fait avait été extraordinaire pour lui-même et pour ses avancées; Il rappelle que les mathématiques sont horizontales, et on n'imagine pas tous les items des mathématiques qui sont présents dans d'autres disciplines.

Plusieurs participants rappellent que, dans tous les emplois, les compétences mathématiques sont mises désormais en avant, et selon N. de Marcellis, le besoin arrive dans toutes les disciplines, alors qu'en parallèle les professeurs au primaire et au secondaire ont du mal à identifier les éléments mathématiques dans leur enseignement, et en particulier ces professeurs pré-universitaires sont extrêmement peu à l'aise en statistiques et considèrent que c'est très difficile.

O. Cornea aborde d'ailleurs un autre thème sur le rôle du CRM: il souligne que celui-ci offre du temps aux chercheurs pour la recherche (par des bourses doctorales, des bourses post-doctorales, et des activités en collaboration); Il souligne que les ateliers et semestres thématiques ne doivent pas être lus seulement sur l'aspect 'dissémination' de la connaissance, mais du temps de recherche collaboratif. C'est d'ailleurs sur ce point de recherche collaboratif que quelques uns des participants voient encore un rôle, dans le futur, aux colloques conférences, puisque d'autres participants pensent qu'il faudrait plus se tourner vers les activités de dissémination en distanciel; en effet, pour le moment, les outils sont insuffisants pour que les vraies collaborations s'engagent par l'intermédiaire des nouvelles technologies. Les analyses de la table ronde s'engagent donc sur la place de l'enseignement versus la recherche dans l'activité des mathématiciens: certains des participants regrettent que l'enseignement prenne de plus en plus de place dans leur activité, et que cela est pénalisant pour la recherche. Un autre bémol souligné au Québec est la présence d'enseignants en mathématiques dans le supérieur ne faisant pas de recherche, essentiellement concentrés dans les CÉGEPs.

Olivier Lafitte
(directeur de l'IRL-CRM du CNRS)



John McKay

(1939-2022)

It is with sadness that we learned of the death of John McKay, a distinguished member of CICMA and the CRM, on April 19 in Montreal. Obtaining a PhD (Computer Science) from the University of Edinburgh in 1971, he joined Concordia University in 1974, becoming a professor in the Department of Computer Science there in 1979. John McKay's work revolved around the properties of finite groups, their representations and their symmetries. He has been at the origin of several of the most startling discoveries in mathematics of our time, and is world-renowned for launching two areas of mathematics by his observations and conjectures, one known as the McKay correspondence, and the other going under the fanciful name of "monstrous moonshine", which aims to explain the relationship between the linear representations of the largest sporadic simple group, known as the monster, and the Fourier coefficients of Klein's modular function j.

Among other achievements, he pioneered in the use of computers as a tool in algebra, both in the study of sporadic groups (he is the co-discoverer of two such groups) or in the explicit computation of Galois groups. He was also one of the principal actors in one of the feats of computational algebra of our time, the proof of the non-existence of a projective plane of order 10. He was elected a fellow of the Royal Society of Canada in 2000 and awarded the CRM-Fields-PIMS prize in 2003.

Memories of John McKay

« John McKay was a good friend, a distinguished colleague, and a very special person, with a unique character. He was remarkable in many ways, both as an imaginative, creative mathematician, well-known for his incredible knack of discovering unexpected relations between seemingly unrelated fields, and as a clear-minded, perceptive thinker, with great honesty and integrity. It followed from this that he could not let things that he perceived as wrong to just go by, without probing their causes. He was also very knowledgeable on a wide range of social, historical, scientific and cultural matters, and it was always interesting and stimulating to communicate with him.

I would like to recall some of the amazing things he discovered, which earned him world renown as a creative mathematical thinker, quite different in his approach from others. His contributions within his fields of specialty, which included, in particular: coding theory, group theory and number theory, were so unique, they were viewed with a certain awe by those who knew of them, even many who could not grasp their detailed significance. He was greatly respected and appreciated throughout the worldwide mathematical community.

There were two special domains, both still under current active study, which came into existence because of his unique insights. One is known as "Monstrous Moonshine" (following the coinage of John Conway and Simon Norton); the other, as the "McKay correspondence". Both relate to properties of transformation groups and symmetries, and

both were inspired by John's remarkable observation of completely unexpected relations between quite distinct domains which, if not for his "second-sight", may never have been recognized. They both bridged what were, a priori, completely unrelated topics concerning invariants and geometry, and led to a huge variety of results and techniques that clarified and rendered more understandable their deeper meaning. And yet, they both remain something of a mystery, and continue to be a source for further development and generalization.

"Monstrous Moonshine" relates linear representations of the biggest sporadic finite simple group, the "Monster", to modular functions, which have a deep number theoretic meaning. This was explained through the work of Richard Borcherds (who was awarded the Fields medal for it in 1998) and others, which implemented the methods of vertex algebras, originating in constructions from quantum field theory, string theory and integrable systems. The "McKay correspondence" arose from another of John's remarkable observations, relating the venerable topic of Platonic solids, and their symmetries, to yet another, completely different group theoretical and combinatorial structure: Dynkin diagrams, which characterize certain continuous transformation groups and reflection groups. In each of these developments, John was responsible for pointing out the "tip of an iceberg": something quite unusual, that subsequently turned out to have deep and remarkable structure beneath.

The importance of these discoveries was accorded due recognition. In 2000, he was elected Fellow of the Royal Society of Canada, and subsequently was awarded a number of prizes and distinctions (in particular, Canada's highest award for outstanding contributions to mathematics, the 2003 CRM-Fields prize).

Numerous international conferences were dedicated to his work, such as: the 2007 conference "Groups and symmetries: from the Neolithic Scots to John McKay", sponsored jointly by Concordia and the CRM, the Conference on resolution of singularities and the McKay correspondence at Nagoya University in 2012 , and the conference on The McKay correspondence, mutation and related topics held online in Japan in August 2020.

His ideas continue to be an inspiration for ongoing research in these fields.

Although our backgrounds and research orientation were rather different (my own being rooted in mathematical physics), we shared a common fascination with symmetry groups, and their appearance in a variety of settings. This led to a brief but fruitful collaboration, on how certain modular functions that play a central role in "Monstrous Moonshine" also provide solutions to a class of differential equations that are of interest in theoretical physics (gauge field theory and the theory of integrable systems) and in geometry (orthogonal coordinate nets and Frobenius manifolds). John was always looking for some new viewpoint (preferably, rooted in physics or geometry) from which to better understand the things that intrigued him. In particular, I think he was never quite satisfied with the explanation for Monstrous Moonshine based on vertex algebras, and always hoped to find some natural geometric or physical basis for the connection, such as a differentiable manifold (possibly, 24 dimensional) upon which the "Monster" acts as a group of symmetries. Maybe, someday, this will be found.

Besides his remarkable mathematical insights and contributions, it would be very incomplete to not say a bit more about John McKay's human qualities, his very high ethical integrity, and his wonderfully wide scope of interests and knowledge, on historical, scientific and cultural matters. In particular, he had a very deep sense of the rights and wrongs regarding how things are done in an academic institutional setting, and never ceased to question things that seemed to him as unjustified or inappropriately prioritized. He was also very frank in expressing such concerns directly to some academic administrators of the time. Though this was always done with courtesy, and in a constructive spirit, his persistent enquiries spurred a rather negative backlash, with harsh measures following. There was a regrettable period in which he was quite unfairly deprived of some of the most elementary benefits due to all faculty members. Fortunately, before he retired, some constructive changes in administration took place which led to a period of improvement in faculty relations. David Graham became Dean of the FAS at Concordia, from 2005 to 2008, before becoming Provost, and did much to countervail the harsh treatment to which John had long been subjected, making sure that he was duly recognized and celebrated by the University, as he had long deserved, for his many distinguished contributions and years of service.

John was a remarkable, many-faceted person, with considerable courage, and a wonderful spirit of endurance. In the final period of his life, this helped carry him through a series of health crises which, during the last four years, sadly, confined him to a permanent care institution. We used to visit him regularly, until the pandemic crisis put a stop to that. After that, we were limited to weekly Zoom conversations, or just telephone contacts. But throughout this time, despite the recurring crises, his company was always enjoyable, and he was able, till the very last year, to keep in touch with other colleagues and friends, with the sustaining support of his devoted wife Trinh. He remained aware of what was going on in the world, and interested in it, till the end, and was still buoyed up by the hope or glimmer of some new mathematical discovery.

He was a good friend and a source of inspiration to the many who knew him, and admired him. He will be sorely missed, and fondly remembered. »

John Harnad
Montreal, May 2022

JOHN MCKAY

« *I first met John in the early 70's when I was at Caltech and he had a visiting position.*

Aside from his energy and broad curiosity, the thing that struck me most was his phenomenal instinct for finding the singular mathematical pearl in a field of marbles. I think that what characterized his remarkable contributions to disparate mathematical areas, was his incredible intuition for identifying those (seemingly mundane) facts which were keys to unlocking deep underlying structures. These drew extensively on his ability to adapt computational methods to abstract mathematical issues.

After his time at Caltech, John came to Montreal where he held positions at McGill and subsequently Concordia. His international reputation gave worldwide visibility to Concordia's Mathematics and Computer Science departments and had an important impact on our recruitment efforts. He was quite influential in my decision to return to Montreal, and participated enthusiastically in helping establish one of Concordia's first interuniversity research centers CICMA.

I will always be grateful for having had John as a friend and colleague. He made Concordia and the world a more interesting place. »

Hershy Kisilevsky

« *I first met John McKay in 1986, when he guided me in an undergraduate summer project. More than any professor I knew at the time or have known since, John conveyed a vivid sense of mathematics as a great intellectual adventure. In his company we were invited to contemplate identities ike 196884 = 196883 + 1, banal to the uninitiated but striking to those in the know, hinting at an occult conspiracy between the fourier coefficients of the modular j-function and the characters of the Monster simple group. In the world of John McKay, mathematics abounded with such shadowy mysteries, and it was our mission to uncover them, like a knight errant or the protagonist in a Dan Brown novel in search of the holy grail or the philosophers stone. McKay's romantic vision of mathematics had a strong impact on how I approach the subject, to this very day. He will be sorely missed.* »

Henri Darmon

« *In the Fall of 1993 I arrived to Montreal to start my first job as a mathematician, a CRM-CICMA postdoctoral position under the supervision of John McKay. I got my undergraduate degree at the Universidad de Chile in Santiago, and my Ph.D. at the University of California in Santa Cruz, so moving to Montreal meant changes in many ways (in particular, a new form to experience winter). My academic experience in the new city was enjoyable and very rewarding. The hospitality and friendly atmosphere created by the local mathematicians made my stay very pleasant. Among all these people, the help and motivation that I got from John McKay was unique. He was always very kind and generous with his time and advice, and to my benefit John was happy to talk math on any occasion. In such conversations he was able to build a very motivating atmosphere with his enthusiasm, wide range of knowledge, and ability to link concepts from distant subjects. Probably this is one of the most important qualities of a mentor, and I am really happy to have had John as a guide at the beginning of my career.*

After two years in Montreal I left for a second postdoc in the US and afterwards I got a permanent position at the Universidad de Chile. I did not go back to Montreal for many years, and I only crossed path with John a couple of times at some math meetings. In 2018 I attended a conference for the celebration of CICMA's postdoctoral program held in Montreal and I had the chance to see John again. The meeting with him was very unusual, but so enjoyable that I have to describe it here. The afternoon following the end of the conference I walked to John's house without previous notice. There I learned that John had a serious health problem a couple of days before, and had to be taken to the hospital in a hurry. Fortunately, he was recovering and had to stay just a few more days in the clinic. His wife Trinh kindly invited me to go to the hospital with her and say hi to John. Of course, I just wanted to take a few minutes to wish him well and leave, in order to avoid a major disturbance. However, this is not what happened. After greeting me from the hospital bed, John asked to be seated on a chair and started an incredible lively chat about recent developments in group theory, differential equations, and their relations with physical theories. He caught me off-guard, but soon I was enjoying a great conversation, full of insights, unexpected math relations and interesting open problems in old and new areas. After two and half hours I said bye to John and Trinh, left the hospital and walked to my hotel. It was a nice summer evening in Montreal, and I was delighted to have had another talk with John. »

Yves Martin,
Santiago, January 2023.

Brenda MacGibbon

(1944-2022)

It is with sadness that we learned of the passing of Brenda MacGibbon in Montreal on October 7.

Brenda MacGibbon was a member of the CRM and its Statistics Laboratory. She studied mathematics at McGill University, obtaining her PhD in 1970. She was the first woman to chair the Statistical Sciences Grant Selection Committee of the NSERC and was a Fellow of the Institute of Mathematical Statistics.

Brenda MacGibbon was known for her work on minimax estimation under constrained parameters spaces, and held positions at the Department of Decision Sciences and Management Information Systems at Concordia University and later at the Département de mathématiques of Université du Québec à Montréal.

Obituary in the Montreal Gazette.

Jiří Patera

(1939-2022)

Jiří Patera est décédé le 3 janvier 2022 à Montréal. Le professeur Patera a eu une longue et fructueuse carrière d'abord comme chercheur au Centre de recherches mathématiques (CRM), puis en tant que professeur au Département de mathématiques et de statistique de l'Université de Montréal.

La carrière scientifique de Jiří Patera s'est étalée sur plus de soixante années et a été menée en Tchécoslovaquie, son pays d'origine, et principalement au Canada, son pays d'adoption. Il a obtenu son doctorat de l'Université technique tchèque de Prague en 1965. Au printemps de 1968, Jiří détenait un visa pour assister à un événement scientifique. Quelques heures avant la fermeture complète des frontières suite à l'invasion russe, lui, son épouse Tania et sa fille Sacha, encore dans les langes, purent s'échapper avec comme tout bagage ce que leur petite auto pouvait transporter. Il fut recruté peu de temps après (août 1969) comme chercheur par le Centre de recherches mathématiques (CRM) qui était alors à créer son équipe scientifique. Il fut intégré comme professeur au Département de mathématiques de l'Université de Montréal en 1984.

Durant toute sa carrière, sa passion fut la recherche, principalement sur la théorie de la représentation des algèbres de Lie simples et leurs généralisations. Jiří fut maître pour établir de longues collaborations fructueuses, par exemple à son arrivée avec Robert T. Sharp de l'Université McGill, son compatriote Pavel Winternitz, lui-même chercheur au CRM, et Hans Zassenhaus de l'University of Notre-Dame, puis, plus tard, avec Robert Moody de l'University of Alberta. Deux Tables, monographies colligeant des données sur les algèbres de Lie simples, ont connu une grande popularité auprès des théoriciens des hautes énergies et des mathématiciens purs oeuvrant en théorie de la représentation. Ces Tables, obtenues à l'ère où la programmation se faisait à l'aide de cartes perforées, furent écrites avec David Sankoff pour la première (1973) et avec Wendy Mackay pour la seconde (1981). (David Rand participa à une version ultérieure de cette seconde Table.) Ses travaux récents ont trouvé des applications en cryptographie (par l'étude des groupes de Coxeter non-cristallographiques) et l'analyse du signal (par l'étude de fonctions définies sur le domaine fondamental d'un système de racines et invariantes sous son groupe de Weyl).

Il fut un mentor auprès de nombreux étudiants et chercheurs postdoctoraux. Dès que la situation politique le permit, il retourna à Prague, après un exil de quelques décennies. Il joua un rôle crucial pour permettre à de nombreux jeunes tchèques de découvrir les domaines qui le passionnaient. Ainsi on trouve, parmi la bonne trentaine de maîtrises et doctorats qu'il a supervisés, de nombreux Tchèques et, évidemment, Canadiens. La cécité qui l'a ralenti durant la dernière décennie ne l'a toutefois pas empêché de travailler avec ses étudiants jusqu'à la fin. Sa carrière scientifique a été honorée entre autres par le Prix ACP-CRM 2004, remis conjointement par l'Association canadienne des physiciens et physiciennes et le CRM, et un doctorat honoris causa en 2006 de l'Université technique tchèque de Prague.

Yvan Saint-Aubin

Nous accueillons vos témoignages à :
communication@crm.umontreal.ca

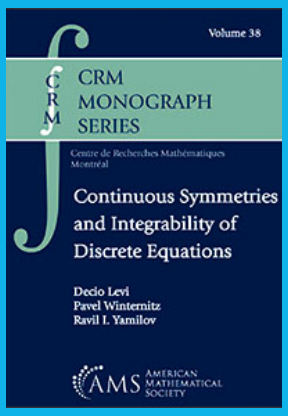
Reminiscences from Robert V. Moody

I first met George in the late 1970s at a meeting of the CMS. He invited me to visit him at the CRM, and so it was that I first came into his circle. (He told me that unless one spoke Czech, Jiři was impossible to pronounce properly, so it was better for us---and him---if we called him George.) That connection blossomed. In the end we wrote some 25 papers together, and our interactions and friendship extended until the very end. We last spoke a few days before his passing. Over the years we met together at the CRM, the Fields Institute, several times at MSRI in Berkeley, at least five times at the Aspen Institute for Physics, in Prague, and later often at the Mind Research Institute in Irvine. In short, George was a huge component of my research and social life. He deeply influenced my appreciation of mathematical physics.

George had the great ability to ask good questions. This is how many of our research efforts began, both in Lie theory and in the theory of aperiodic order. Some of them ended up being amazingly interesting. That questioning mind, and also his habit of throwing students into the deep end and getting them really excited about research right from the beginning, account for some of his amazing success in advancing the mathematical lives of so many students who are fully-fledged mathematicians today.

As a person he was tremendously even-keeled, kind, and unaffected. We enjoyed each other's company over the course of some forty years. In the past ten years it was so impressive to see how, even afflicted with ever debilitating blindness, he continued to teach and inspire young researchers. We talked about his blindness, but he never once complained about it. His was a scientific life very well lived. We shall all miss him tremendously.

CRM Proceedings (in Contemporary Mathematics, AMS)



Continuous Symmetries and Integrability of Discrete Equations

Decio Levi (Roma Tre University),
Pavel Winternitz (Université de Montréal),
Ravil I. Yamilov (UFA Federal Research Center of the Russian Academy of Science)
– AMS | CRM, 2023, 496 pp.

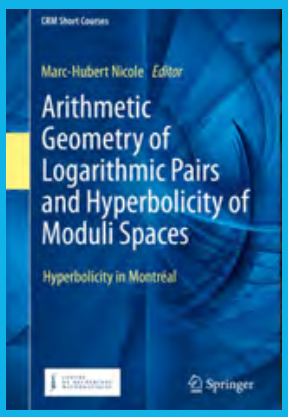
Hardcover / eBook

This book on integrable systems and symmetries presents new results on applications of symmetries and integrability techniques to the case of equations defined on the lattice. This relatively new field has many applications, for example, in describing the evolution of crystals and molecular systems defined on lattices, and in finding numerical approximations for differential equations preserving their symmetries.

The book contains three chapters and five appendices. The first chapter is an introduction to the general ideas about symmetries, lattices, differential difference and partial difference equations and Lie point symmetries defined on them. Chapter 2 deals with integrable and linearizable systems in two dimensions. The authors start from the prototype of integrable and linearizable partial differential equations, the Korteweg de Vries and the Burgers equations. Then they consider the best known integrable differential difference and partial difference equations. Chapter 3 considers generalized symmetries and conserved densities as integrability criteria. The appendices provide details which may help the readers' understanding of the subjects presented in Chapters 2 and 3.

This book is written for PhD students and early researchers, both in theoretical physics and in applied mathematics, who are interested in the study of symmetries and integrability of difference equations.

CRM Short Courses (Springer)



Arithmetic Geometry of Logarithmic Pairs and Hyperbolicity of Moduli Spaces: Hyperbolicity in Montréal

Edited by Marc-Hubert Nicole.

CRM Short Courses Series | Springer, 2021, 247 pp.

Hardcover / Softcover / eBook

This publication introduces a number of exciting developments and cutting-edge results related to hyperbolicity, and the fundamental conjectures of Ax–Schanuel, Bombieri, Campana, Lang, Vojta, and others. It features chapters written by leading experts in their areas, collecting many of their own recent advances. The publication motivates a range of readers by presenting each chapter's respective material in a self-contained and accessible manner.