Le BULLETIN

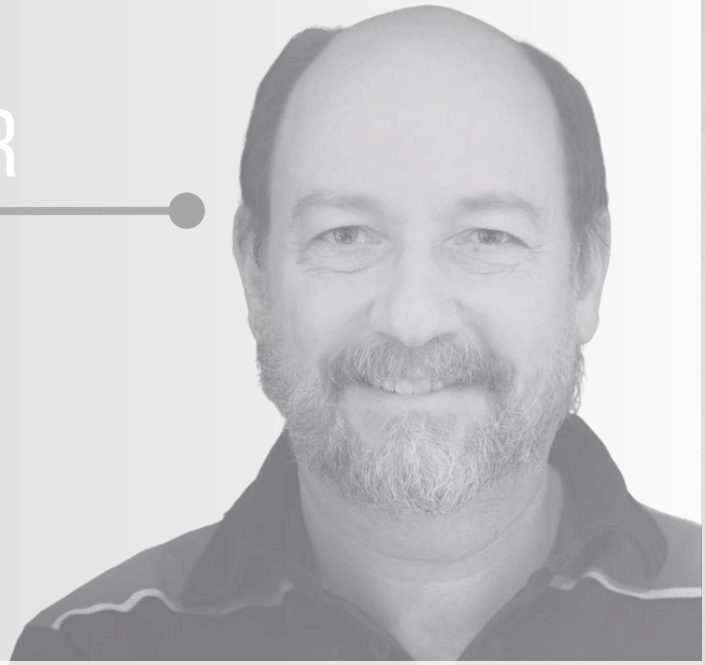
CENTRE DE RECHERCHES MATHÉMATIQUES

Printemps / *Spring*
2024

Volume 29 - N°1 ISSN 1492-7659

MOT DU DIRECTEUR

Octav Cornea



Le CRM commence l'année 2024 après la conclusion d'un programme thématique sur la modélisation du cerveau à l'automne 2023 qui a attiré la participation de centaines de chercheurs du monde entier et en préparant le programme en analyse géométrique qui s'en vient, au printemps-été 2024. Parmi les activités de sensibilisation qui nous ont marqués à noter deux Grandes Conférences, celle de Normand Mousseau le 21 septembre 2023 portant sur la carboneutralité qui nous a interpellés sur ce thème si actuel, et la présentation de Nadia Lafrenière à l'occasion de la journée de Pi 2024 qui nous a délectés en nous dévoilant des relations inattendues entre les jeux de cartes et des éléments profonds de la théorie des probabilités.

D'autres points à relever :

Un groupe de chercheurs du CRM vient de recevoir un financement de la part du FRQNT dans le cadre du nouveau programme Stratégia pour appuyer la Modélisation des défis émergents. Un autre groupe se retrouve intégré de façon organique dans le réseau Santé numérique qui a récemment reçu l'appui du FRQS. Les deux nouvelles structures vont collaborer avec le CRM en renforçant une large gamme de programmes et activités pertinentes.

Les 27-28 février, le CRM a accueilli une activité pour évaluer, échanger et discuter des relations avec les mathématiques de France, avec un accent particulier sur les activités de l'IRL – CRM. De courte durée mais de grande intensité, cette activité a fait intervenir plus de 70 participants dont Alejandro Adem (Président du CRSNG), Janice Bailey (Directrice Scientifique du FRQNT), Jean-Stephane Dhersin et François James (directeurs adjoints de l'INSMI du CNRS), ainsi que les VRR des universités partenaires institutionnels du CRM, les directeurs de laboratoires du CRM et de nombreux chercheurs et chercheuses.

Des processus de nomination et selection sont en cours pour remplacer Galia Dafni au poste de Directrice Adjointe, dont le mandat arrive à terme à la fin juin 2024, ainsi que le Directeur dont le mandat prend fin en juin 2025.

Toujours concernant l'équipe du CRM, notre collègue Vincent Masciotra, vrai pilier de l'institution pendant plus de 25 ans, vient de prendre sa retraite à la fin février. Ses contributions à l'établissement ont été marquées par une émouvante célébration d'équipe, avec la participation d'anciens directeurs et d'autres chercheurs et chercheuses.

A WORD FROM THE DIRECTOR

The CRM begins 2024 after concluding a thematic program on brain modeling in the fall of 2023, which attracted the participation of hundreds of researchers from around the world, and preparing for the upcoming program in geometric analysis in the spring-summer of 2024. Among the outreach activities of note were two Grandes Conférences: a lecture by Normand Mousseau on carbon neutrality on September 21, 2023, which challenged us on this highly topical theme, and Nadia Lafrenière's presentation on Pi Day, 2024, which delighted us by revealing unexpected relationships between card games and profound elements of probability theory.

Other points to note:

A group of CRM researchers has just received funding from the FRQNT as part of the new Stratégia program to support Modeling of Emerging Challenges. Another group has found itself organically integrated into the Santé numérique network, which has been recently funded by the FRQS. The two new structures will collaborate with the CRM in reinforcing a wide range of relevant programs and activities.

On February 27-28, the CRM hosted an event to evaluate, exchange and discuss relations with French mathematics, with a particular focus on IRL - CRM activities.

This short but intense event involved over 70 participants, including Alejandro Adem (President of NSERC), Janice Bailey (FRQNT Scientific Director), Jean-Stephane Dhersin and François James (INSMI CNRS Deputy Directors), as well as the VRRs of CRM's institutional partner universities, CRM laboratory directors and numerous researchers.

Searches are underway to replace Galia Dafni as Deputy Director- her term of office finishes at the end of June 2024, and the Director, whose term of office ends in June 2025.

Still on the subject of the CRM team, our colleague Vincent Masciotra, a true pillar of the institution for over 25 years, has retired at the end of February. His contributions to the establishment were marked by a moving team celebration, with the participation of former directors and other researchers.

EN BREF ROUND-UP

GEOMETRIC ANALYSIS

APRIL - JUNE | 2024

THEMATIC PROGRAM

Overview

The last few years have seen spectacular progress on a variety of very difficult geometric problems. Probably the most familiar of these problems to the general mathematical audience is the solution of the Poincaré conjecture, but the general idea of taking a canonical variational flow to obtain geometric objects of interest of course has its origins much earlier, notably in the work of Yau, of Donaldson, and of several others in the 1970s and 1980s. The more recent Ricci flow solution of the Poincaré conjecture has stimulated a whole series of major breakthroughs in related areas of geometry, notably in complex and Kähler geometry, for example in the solution of the Kähler-Einstein existence problem for Fano varieties.

While there is a hard core of non-linear pde to the subject, to a certain degree the ideas are often reflections of finite dimensional ones; not only the quite classical idea of a gradient flow, but also the more technical notion of stability emerging from algebraic geometry, and a concomitant interest in moduli problems and in singularities.

This semester-long program in geometric analysis will focus mostly on complex geometry and Kähler geometry, but with the occasional excursion into real geometry. While the inspiration has deep geometrical roots, the tools are to a large degree those of partial differential equations.

PROGRAM

PDEs in Complex Geometry

April 15-19, 2024

Special Riemannian Metrics in Dimensions 6,7,8

April 22-26, 2024

Analysis of Geometric Singularities

May 13-17, 2024

Moduli Spaces and Singularities

May 20-24, 2024

Current Trends in Kähler Metrics with Special Curvature Properties

June 17-21, 2024

Current Trends in Geometric Flows

June 25-29, 2024

Plus d'information

ANALYSE GÉOMÉTRIQUE

AVRIL - JUIN | 2024

CHAIRE AISENSTADT

Les titulaires de la Chaire Aisenstadt donnent une série de conférences sur un sujet déterminé pour son intérêt et son impact dans le cadre de la programmation thématique, dont la première, à la demande du donateur André Aisenstadt, doit être accessible à un large auditoire.

Simon Brendle (Columbia University)

Simon Brendle a résolu au cours de sa carrière plusieurs conjectures ou problèmes majeurs en géométrie différentielle, par exemple en fournissant une preuve de convergence du flot de Yamabe en toute dimension, en démontrant (avec Richard Schoen) le théorème de la sphère dans sa forme différentiable, en démontrant la conjecture de Hsiang-Lawson.

More information

1 - 3 mai 2024

8- 10 mai 2024

More information

Panagiota Daskalopoulos (Columbia University)

Panagiota Daskalopoulos est une des grandes expertes des flots géométriques. Ses travaux récents portent plutôt sur le contexte géométrique, en particulier les solutions « anciennes » existant sur un intervalle de temps semi-infini vers la gauche. Elle est membre de l'American Academy of Arts and Sciences et a reçu le prix Ruth Lyle Satter de l'AMS en 2023.

DYNAMIQUE COMPUTATIONNELLE

ANALYSE, TOPOLOGIE ET DONNÉES

SEPTEMBRE - NOVEMBRE | 2024

PROGRAMME THÉMATIQUE

Aperçu

Le semestre thématique intitulé « Dynamique computationnelle : Analyse, topologie et données » est une initiative collaborative et interdisciplinaire visant à relever les défis de l'identification de structures dynamiques explicites dans des systèmes non linéaires complexes, en particulier ceux qui sont de grande dimension ou mal résolus. Dans des contextes aussi complexes, les mathématiques computationnelles apparaissent comme le principal outil permettant d'acquérir des connaissances plus approfondies et d'extraire des caractéristiques dynamiques fondamentales. Ce semestre fournira aux chercheurs une plate-forme pour approfondir trois sujets de recherche principaux, chacun contribuant à notre compréhension de la dynamique non linéaire et de leur analyse computationnelle.

Sujets de recherche :

R1 Les équations différentielles computationnelles rigoureuses.

R2 La topologique combinatoire pour étudier la dynamique non linéaire.

R3 La dynamique basée sur les données.

PROGRAMMME

Tutoriel - Preuves assistées par ordinateur en analyse non linéaire

5-6 septembre 2024

Atelier - Preuves assistées par ordinateur en analyse non linéaire

9-13 septembre 2024

Tutoriel - Cadre topologique combinatoire pour la dynamique non linéaire

3-4 octobre 2024

Atelier - Cadre topologique combinatoire pour la dynamique non linéaire

7-11 octobre 2024

Atelier - Dynamique fondée sur les données

11-15 novembre 2024

More information

COMPUTATIONAL DYNAMICS

ANALYSIS, TOPOLOGY AND DATA

SEPTEMBER - NOVEMBER | 2024

AISENSTADT CHAIR

Rachel Kuske (Georgia Institute of Technology)

Rachel Kuske's research brings stochastic and multiscale perspectives to applied nonlinear, non-smooth and delayed dynamics. A Professor of Mathematics at the Georgia Institute of Technology, where she was also department chair from 2017-2021, Kuske previously held a Canada Research Chair at the University of British Columbia. A SIAM Fellow since 2015, Professor Kuske received the CMS Krieger-Nelson prize (2011), an AWM Service Award (2013), and a Simons Fellowship at the Newton Institute in Cambridge (2016).

Plus d'information

3 - 11 oct. 2023

5- 13 sept. 2023

Plus d'information

Javier Gòmez-Serrano (Brown University)

Javier Gómez-Serrano's research lies at the boundary between computer-assisted proofs, partial differential equations, numerical computation, and machine learning. An Associate Professor at Brown University, he was previously an Instructor and Assistant Professor at Princeton University and a Distinguished Researcher at Universitat de Barcelona. Professor Gómez-Serrano received the 2023 Antonio Ambrosetti Medal, the 2018 Antonio Valle Prize (Best Spanish Applied Mathematician under 33), and the 2017 Vicent Caselles Prize (Best Spanish Mathematicians under 32).

THÉORIE GÉOMÉTRIQUE DES GROUPES

MARS - JUIN | 2023

PROGRAMME THÉMATIQUE

Théorie des groupes mesurée

6-17 mars 2023

Groupes énormes

3-6 avril 2023

Groupes ordonnés

24 avril - 5 mai 2023

Géométrie des sous-groupes

15 au 26 mai 2023

Complexes cubiques

19-30 juin 2023

Groupes autour de 3-variétés

5-16 juin 2023

GEOMETRIC GROUP THEORY

MAI - JUIN | 2023

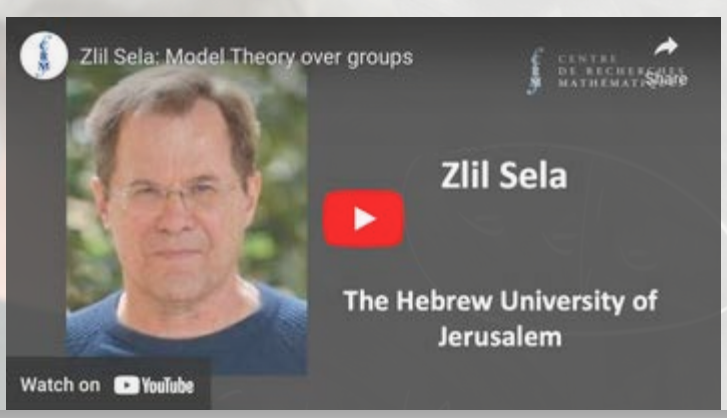
AISENSTADT CHAIR LECTURES

Zlil Sela

(Hebrew University)

May 30, 2023 - June 12, 2023

- On rates of growth in groups
- Model theory over groups
- Automorphisms of groups and a higher rank JSJ decomposition



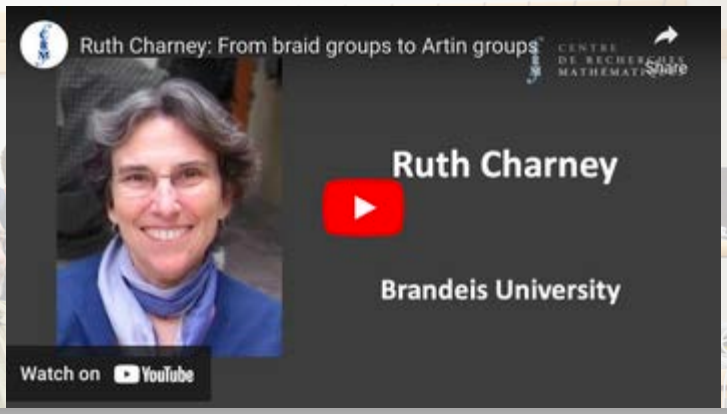
© Richard Poissant

Ruth Charney

(Brandeis University)

June 21 - 28, 2023

- From braid groups to Artin groups
- Geometric approaches to Artin groups
- Outer Space for right-angled Artin groups



© Richard Poissant

MODELING & SIMULATING THE BRAIN

JUILLET- DÉCEMBRE | 2023

AISENSTADT CHAIR

Stéphane Jaffard

(Paris Est-Créteil)

Oct. 27 - Nov. 02, 2023

- On the hunt for chirps
- Classification and detection of local singularities of functions and signals: time-scale vs. time-frequency methods.

© *Richard Poissant*

Jul. 3 - 14, 2023

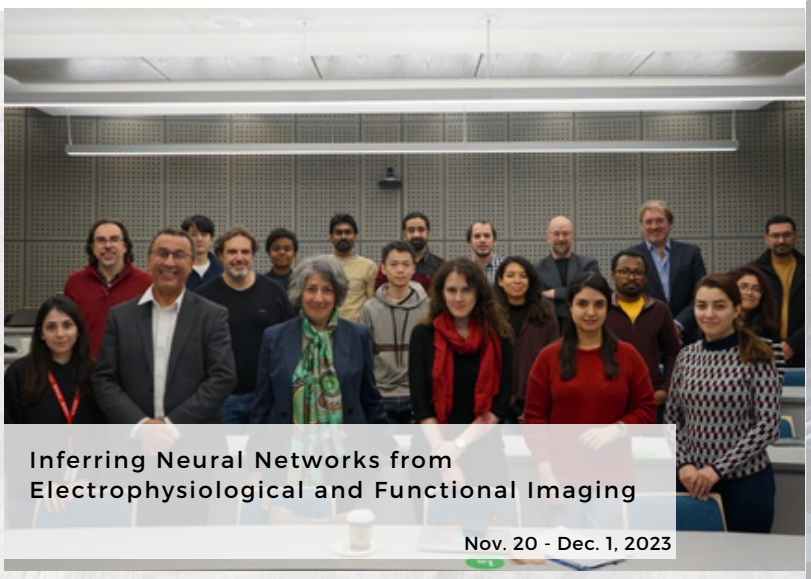
- Harmonic and Multifractal Analyses: from Mathematics to Quantitative Neuroscience

Oct. 10 - 13, 2023

- Advances in NeuroAI

Oct. 12 - 19, 2023

- Vascular and Metabolic Modeling of the Brain at Large Scale



Inferring Neural Networks from Electrophysiological and Functional Imaging

Nov. 20 - Dec. 1, 2023

GRANDES CONFÉRENCES

Yvan Saint Aubin

(Université de Montréal)

14 mars 2023

Sur une gravure de M.C. Escher

JOURNÉE INTERNATIONALE DES MATHÉMATIQUES 14 MARS

© *Richard Poissant*

René Doyon

(Université de Montréal)

5 mai 2023

Les premiers résultats du télescope James-Webb

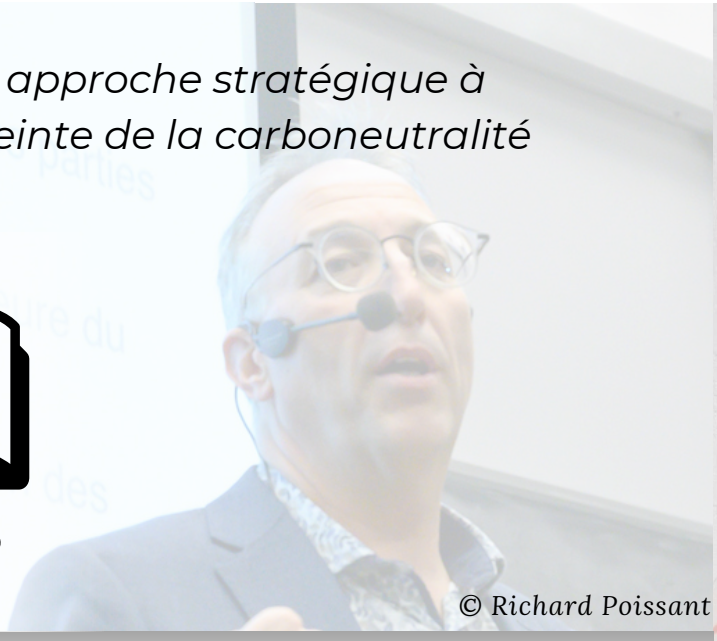
GRANDES CONFÉRENCES

Normand Mousseau

(Université de Montréal)

21 sept. 2023

Une approche stratégique à l'atteinte de la carboneutralité



© Richard Poissant

Nadia Lafrenière

(Université Concordia)

14 Mars 2024

Tricher à l'aide des mathématiques

© Richard Poissant

CRM NIRENBERG LECTURES

Misha Bialy

(Tel Aviv University)

Oct. 16-18, 2023

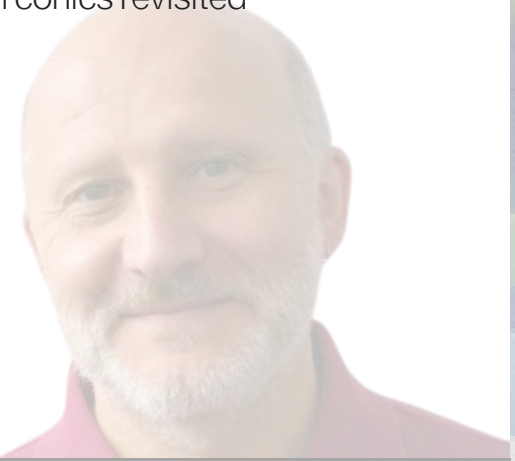
- Integrable billiards and rigidity I - II

Sergei Tabachnikov

(Pennsylvania State University)

Oct. 19-20, 2023

- Billiard-like maps and Dowker-style theorems
- Billiards in conics revisited



PRIX ANDRÉ AISENSTADT

Créé en 1991, le Prix de mathématiques André-Aisenstadt, comprenant une bourse ainsi qu'une médaille, souligne des résultats exceptionnels de recherche en mathématiques pures ou appliquées, réalisés par un ou une jeune membre de la communauté de recherche en mathématique au Canada.

Yakov Shlapentokh-Rothman (University of Toronto)

Yakov Shlapentokh-Rothman a obtenu son doctorat au MIT en 2015 sous la direction d'Igor Rodnianski. Après une bourse postdoctorale de la NSF à l'Université de Princeton (2015-2018), il y est resté en tant que professeur adjoint avant de se joindre au département de mathématiques de l'Université de Toronto en 2021.

Elina Robeva (University of British Colombia)

Elina Robeva a obtenu son doctorat à l'Université de Californie à Berkeley en 2016, sous la direction de Bernd Sturmfels. Sa thèse a été récompensée par le Prix Bernard Friedman de Berkeley en mathématiques appliquées. Après une bourse postdoctorale de la NSF au MIT (2016-2019), elle a rejoint le département de mathématiques de UBC en 2019.

CRM - FIELDS-PIMS PRIZE

The CRM-Fields-Pacific Institute for the Mathematical Sciences (PIMS) prize is the premier Canadian award for research achievements in the mathematical sciences.

Christian Genest (McGill University)

Christian Genest is one of Canada's leading statisticians. His fundamental research has had many practical repercussions. In particular, he has contributed to multivariate analysis and was one of the pioneers of the widespread use of copula models in science.

Ram Murty (Queen's University)

Ram Murty works on a wide front, with imagination and originality, combining both analytic and algebraic techniques and bringing real philosophical depth to the questions he considers. Few parts of the subject of number theory, including its ties to far-afield topics like mathematical logic, p-adic geometry, and foundations, have been left untouched by his wide-ranging intellectual curiosity.

PRIX CRM-SSC EN STATISTIQUE

Le Centre de recherches mathématiques (CRM) et la Société statistique du Canada (SSC) sollicitent des candidatures pour le Prix CRM-SSC offert à une personne s'étant distingué par ses travaux de recherche en sciences statistiques au cours des quinze premières années suivant l'obtention de son doctorat.

Zhou Zhou (Université de Toronto) 2023

Zhou est un chercheur prolifique, original et indépendant dans le domaine de l'analyse des séries temporelles et des statistiques non paramétriques. Il a un palmarès de recherche impressionnant, avec 31 articles de recherche publiés ou acceptés dans des revues de haut niveau.

CAP-CRM PRIZE

The objective of this award is to recognize research excellence in the fields of theoretical and mathematical physics. The annual CAP-CRM Prize in Theoretical and Mathematical Physics was first introduced in 1995, on the occasion of the 60th anniversary of the CAP.

David London (Université de Montréal) 2022

David London is a particle theorist with an international reputation. Throughout his career, he has examined many different possibilities for the new physics. He is best known for his work in B physics. Dr. London has also studied a wide variety of other new-physics possibilities. It is for his pursuit of physics beyond the Standard Model that David London was awarded the CAP-CRM Prize in Theoretical and Mathematical Physics.

Yanqin Wu (University of Toronto) 2023

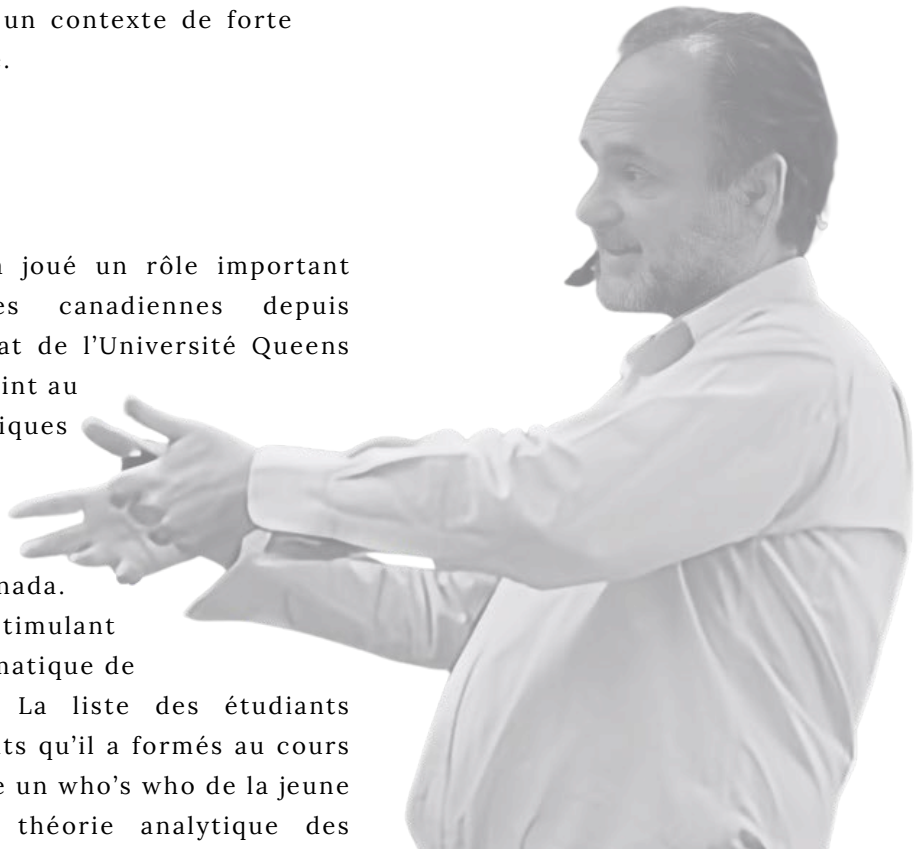
Yanqin Wu is a prolific, imaginative, and deep-thinking theoretical physicist whose work has revolutionized our understanding of how planets form and evolve. She provided the first complete description of how massive planets like Jupiter can form closer to their host star than any planets in the solar system, through dynamical oscillations induced by the tidal field of distant companions.

CHERCHEUR DISTINGUÉ DU CRM

CHERCHEUR DISTINGUÉ DU CRM

Le but de ce nouveau programme est d'appuyer activement l'engagement des chercheurs et des chercheuses membres du CRM par rapport aux activités du Centre, dans un contexte de forte compétition internationale.

Andrew Granville



Le professeur Granville a joué un rôle important dans les mathématiques canadiennes depuis l'obtention de son doctorat de l'Université Queens en 1987. En 2002, il s'est joint au Département de mathématiques et de statistique de l'Université de Montréal à titre de titulaire d'une chaire de recherche du Canada. Sa présence a eu un effet stimulant sur la communauté mathématique de Montréal en particulier. La liste des étudiants diplômés et post-doctorants qu'il a formés au cours de sa carrière se lit comme un who's who de la jeune génération d'experts en théorie analytique des nombres, y compris plusieurs mathématiciennes de premier plan.

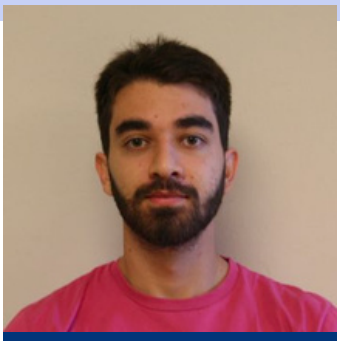
Le professeur Granville nous a fait part de ses pensées quant aux changements fondamentaux les ordinateurs apporteront-ils à la recherche mathématique. Ces changements modifieront-ils ce que nous croyons et ce que nous sommes ?

LES POST-DOCS

BOURSIERS POSTDOCTORAUX

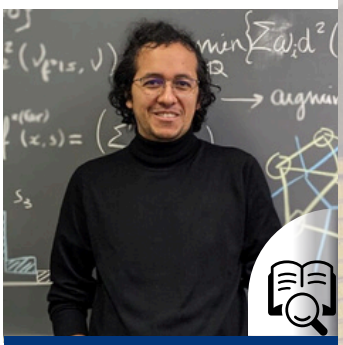
CRM - ISM

Chi Cheuk Tsang
(PhD | University of California, Berkeley)



Panagiotis Dimakis
(PhD | Stanford University)

Luis Nerio Scoccola
(PhD | University of Oxford)



Dante Mata-Lopez
(PhD | Mathematics Research Center, CIMAT)

BOURSIER POSTDOCTORAL

CRM - Laval

Ryan O'Loughlin
(PhD | University of Leeds)

BOURSIER POSTDOCTORAL

CRM - uOttawa

Zaoli Chen
(PhD | Cornell University)

LES FEMMES EN MATHEMATIQUES

EQUITÉ, DIVERSITÉ & Inclusion

Journée internationale des femmes

8 mars 2023

Les femmes de la stochasticité

13 mai 2023

Célébrer les femmes dans les sciences mathématiques

12 mai 2023

Projection de Film & Table ronde

13 mai 2023

Une initiative nationale pour promouvoir les mathématiques et les STIM

Depuis quatre ans, le Centre de recherches mathématiques et le Centre interuniversitaire de recherche en analyse des organisations (CIRANO) ont lancé l'initiative nationale « En avant math! » pour promouvoir les mathématiques et accroître la numératie.

Finances Québec

CIRANO

L'objectif est de favoriser le développement d'une main-d'œuvre hautement qualifiée en mathématiques appliquées pour des domaines de pointe. Cette initiative est appuyée financièrement par le ministère des Finances du Québec.

Ensemble, nous sommes catalyseurs de croissance en sciences mathématiques !

RÉUNION D'EXPLORATION ET D'ÉVALUATION : L'IRL-CRM ET LA COOPÉRATION FRANCE-QUÉBEC EN SCIENCES MATHÉMATIQUES

27-28 février 2023

IRL - CRM

Ce IRL, créé d'abord pour une période de quatre ans en 2011 et renouvelé en 2015 et en 2021, a pour mission de donner un cadre institutionnel à la coopération fructueuse France-Québec en sciences mathématiques, et de permettre d'accroître les collaborations entre mathématiciens français et québécois.

Le CRM bénéficie d'un appui du FRQNT dans le cadre de l'entente établissant le CRM comme IRL du CNRS. Ce soutien permet au CRM d'offrir à ses membres scientifiques et à ses étudiantes et étudiants la possibilité de séjour de courte ou de moyenne durée en France.

CRM-CNRS International Research Lab

Québec
Fonds de recherche – Nature et technologies
Fonds de recherche – Santé
Fonds de recherche – Société et culture

Table-ronde

De gauche à droite

- **Christian Agbobli** (Vice-recteur à la Recherche, à la création et à la diffusion, UQAM)
- **François James** (Directeur scientifique adjoint INSMI - CNRS)
- **Octav Cornea** (Directeur, CRM)
- **Janice Bailey** (Directrice scientifique, FRQNT)
- **Alejandro Adem** (Président, CRSNG)
- **Serge Denoyers** (Adjoint à la vice-rectrice à la recherche, à la création et à l'innovation, Université de Laval)
- **Jean-Stéphane Dhersin** (Directeur scientifique adjoint INSMI - CNRS)
- **Lyes Kadem** (Vice recteur adjoint à la recherche, Université Concordia)
- **Olivier Lafitte** (Directeur, IRL-CRM)

Non visible sur la photo

- **Benoit Boulet** (Vice recteur adjoint à la recherche, McGill University)

PUBLICATIONS

MOT DU DIRECTEUR ADJOINT

Benoit Durand-Jodoin

Le fonctionnement quotidien d'un institut de recherche nécessite l'implication de nombreuses personnes aux compétences diversifiées. Le CRM a la chance de compter sur une équipe de personnel de soutien composée de 16 personnes dévouées, qui s'occupent autant de la logistique et de l'administration des programmes que des communications et du bon fonctionnement des systèmes informatiques et audiovisuels.

Au cours l'année 2023, la direction a revu la structure de cette équipe et a procédé à certains ajustements pour s'assurer du bon fonctionnement des programmes de l'institut.

Nous avons regroupé les activités des laboratoires avec les programmes de mobilité, de formation et de valorisation au sein d'une nouvelle équipe et créé un poste de coordinateur principal pour la superviser. Après quelques mois, nous voyons les résultats : meilleur suivi des demandes, simplification des processus et amélioration de la vision globale des programmes.

L'équipe d'activités scientifiques était bien structurée, mais la charge de travail était trop lourde pour sa taille et les activités du programme général étaient réparties entre plusieurs personnes, ce qui compliquait la coordination.

Nous avons donc confié les activités du programme général à une agente de coordination, créé un second poste pour les programmes thématiques et embauché un technicien en bureautique et administration à temps partiel pour compléter l'équipe. Ainsi, la coordonnatrice peut se consacrer davantage à la planification générale et au suivi des programmes d'activités scientifiques.

Enfin, trois groupes complètent l'équipe : les communications, dont la responsabilité est assumée par l'agente de coordination des programmes thématiques, les finances et les TI.

En plus d'améliorer le fonctionnement des programmes et activités, cette restructuration a été l'occasion de promouvoir trois employés qui poursuivent leur développement professionnel au CRM.

Le mot de la fin va à cette équipe : merci pour votre engagement et vos efforts quotidiens, c'est fort apprécié!

CENTRE DE RECHERCHES MATHÉMATIQUES

Notre équipe

Direction

Octav Cornea
Directeur
Bureau 5361

Galia Dafni
Directrice adjointe – programmes scientifiques, publications et communications
Bureau 5321

Benoit Durand-Jodoin
Directeur adjoint – administration
Bureau 5351

Formation, mobilité et laboratoires

Guillermo Martinez-Zalce
Coordonnateur principal
Bureau 5375

Mozhgan Moeintaghavi
Agente de coordination
Bureau 5381

Thomas Sincan
Technicien en administration
Bureau 5359

Camila B. Dantas
Technicienne en administration
Bureau 5371

Finances et administration

Elena Pukhaeva
Agente de gestion financière
Bureau 5369

Diane Brûlé de Filippis
Technicienne en administration
Bureau 5359

TI

Ricardo Briceño
Conseiller informatique
Bureau 5349

Madid Rahani
Analyste informatique
Bureau 5377

Communications et publications

Marion Cesari
Agente de coordination
Bureau 5339

Edouard Pointoizeau
Technicien communication marketing
Bureau 5339

Activités scientifiques

Virginie Leduc
Coordonnatrice
Bureau 5343

Sakina Benhima
Agente de coordination
Bureau 5367

Marion Cesari
Agente de coordination
Bureau 5339

Alex Phan-Vo
Technicien en administration
Bureau 5345

Maëva Singre
Technicienne en administration
Bureau 5345

En congé :

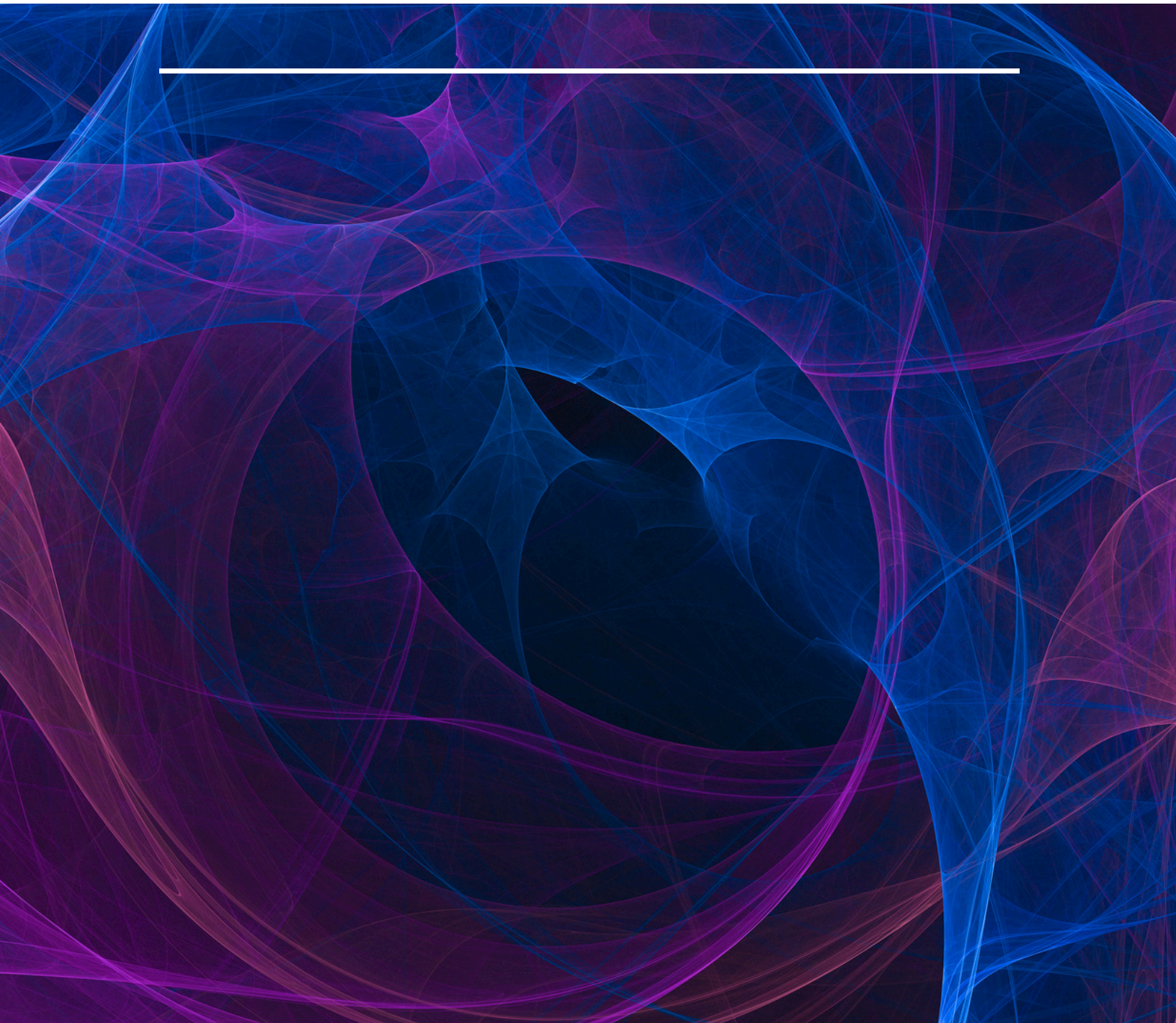
Flore Lubin
Agente de coordination

Rhode Ménard
Agente de coordination

Départ à la retraite :

Vincent Masciotra
Coordonnateur

EN DÉTAIL
IN DETAIL



PROGRAMMES THÉMATIQUES

© Richard Poissant

Orderable Groups

APR. 24 - MAY. 5, 2023

GEOMETRIC GROUP THEORY

Two weeks of activities on orderable groups were held as part of the CRM's thematic semester Geometric Group Theory. This is a classic area of research which has experienced a renaissance in recent years owing to its appearance in geometric group theory, Lie theory, dynamics and low-dimensional topology, to name a few.

During the first week, over 40 early-career mathematicians from around the world attended an advanced school at UQAM, consisting of four minicourses on order structures on groups and their relation to the dynamics of group actions on the circle and the real line:

Minicourse 1: Introduction to order structures in groups

- Adam Clay, University of Manitoba

Minicourse 2: *Introduction to circular orderings*

- Tyrone Ghaswala, University of Waterloo

Minicourse 3: *Countable subgroups of homeomorphism groups, dimension 1 and beyond*

- Thomas Koberda, University of Virginia

Minicourse 4: *Spaces of orderings and applications*

- Andrés Navas, University of Chile at Santiago

The minicourses were capped off by problem sessions (four in total) discussing open problems and conjectures, giving early-career researchers a broad introduction to the goals and directions of modern work in the field. One participant remarked that this event had a huge impact on his student, and many early-career researchers came away with new (or renewed) motivation and interest in the field.

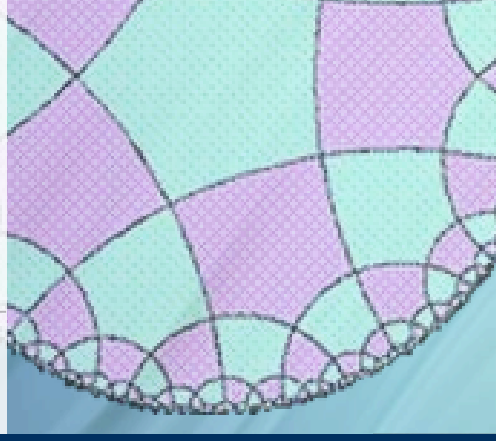
During the second week, a workshop was held at the CRM on orderable groups and related topics, covering the full spectrum of contemporary research in the area. There were seventeen talks delivered by researchers from Quebec, Canada, the United States, South America, Europe and Asia. This second week of activities was successful in connecting researchers from extremely varied research backgrounds around a common theme of order structures on groups. With attendees and speakers from fields such as logic and set theory, automata theory, low-dimensional topology and dynamics, participants were able to make connections with researchers from different mathematical backgrounds, finding potential collaborations at the intersection of diverse areas of mathematics.

- **Organizers**

Steven Boyer (UQAM)
Adam Clay (University of Manitoba)

Groups Around 3-Manifolds

JUNE. 5-16, 2023



GEOMETRIC GROUP THEORY

As part of the thematic program on Geometric Group Theory, the CRM hosted an intense two-week workshop on Groups Around 3-Manifolds. The first week of the workshop featured mini-courses by four researchers who are renowned for both their results and their expository skill.

Nathan Dunfield (of the University of Illinois at Urbana-Champaign) described a large number of both theoretical and practical consequences of Perelman's Geometrization Theorem. This theorem makes it possible to algorithmically distinguish 3-manifolds using geometry, and provides practical tools for distinguishing their fundamental groups using finite-index subgroups. Continuing with this theme, Michelle Chu (of the University of Minnesota) surveyed several recent breakthroughs in our understanding of the virtual properties of 3-manifold groups. She described the notion of subgroup separability and explained how results about surface subgroups led to the cubulation and virtual specialization of 3-manifold groups, implying that nonpositively curved 3-manifolds are virtually fibered.

Ian Biringer (of Boston College) gave a mini-course focused on the rank of 3-manifold groups. He explained the relation of rank to Heegaard genus, surveyed some results and open questions about the behavior of rank in finite covers, and introduced the technology of carrier graphs.

Finally, Daniel Groves (of the University of Illinois at Chicago) gave a mini-course focused on two major open problems: the Wall Conjecture that every PD(3) group is a 3-manifold group and the closely related Cannon Conjecture that every torsion-free hyperbolic group with S^2 boundary is a hyperbolic 3-manifold group. He surveyed some recent results that reduce the Cannon conjecture to the problem of cubulating (relatively) hyperbolic groups with S^2 boundary.

The second week of the workshop featured conference lectures by 20 different researchers. Major themes covered by the research talks included profinite rigidity (the determination of a group by its finite quotients); arithmeticity of 3-manifold groups; representations of 3-manifold groups into Lie groups; subgroup separability; and various forms of the Cannon conjecture.

Finally, the two-week workshop featured three fast-paced sessions of lightning talks and a discussion session focused on open problems. These events gave every attendee an opportunity to participate by sharing their work and describing questions that they find exciting.

- **Organizer**

David Futer (Temple University)

GRANDES CONFÉRENCES

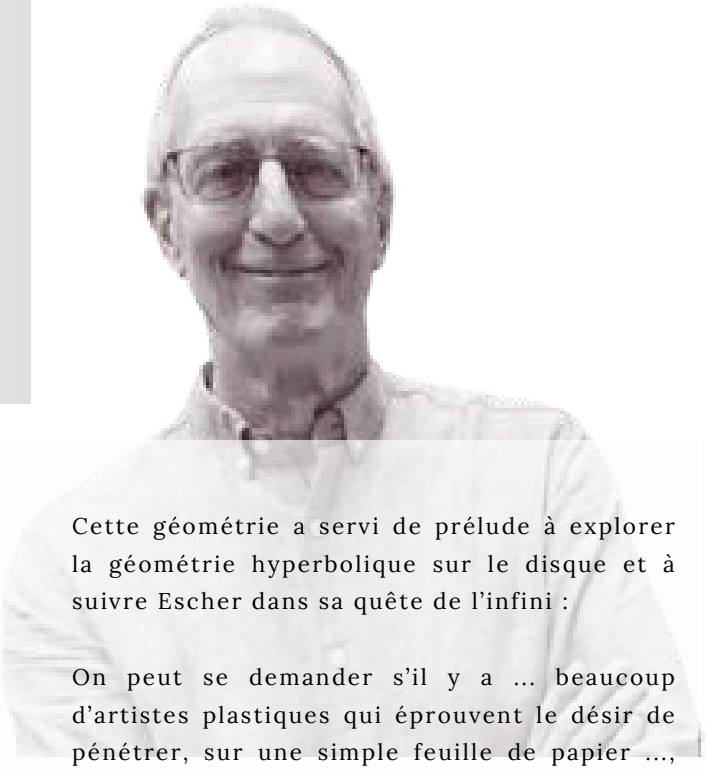
Sur une gravure de M.C. Escher

JOURNÉE INTERNATIONALE DES MATHÉMATIQUES 14 MARS

Yvan Saint Aubin (Université de Montréal)

GRANDES CONFÉRENCES

L'UNESCO avait proclamé le 14 mars Journée internationale des mathématiques en novembre 2019. Le 14 mars 2023 marquait la première célébration de cette journée en présentiel depuis sa proclamation. Pour l'occasion, le public a été convié à une grande conférence publique donnée par Yvan Saint Aubin, précédée d'un vin-fromage lors duquel le public a pu explorer les symétries de frises et de polyèdres en discutant avec Shophika Vaithyanathasarma et Charles Sénécal, tous deux étudiant à la maitrise.



Le titre de la conférence d'Yvan Saint-Aubin était « Sur une gravure de M.C. Escher ». La conférence a commencé par explorer les pavages et leurs symétries depuis les temps les plus anciens jusqu'au 20e siècle. Un des thèmes récurrents de la conférence a été d'identifier la plus petite tuile qu'on peut utiliser pour paver le plan avec un motif donné qui se répète avec une forme de périodicité. Dans un premier temps, le conférencier a regardé les pavages euclidiens du plan.

En introduction à la géométrie sphérique, le public a ensuite eu droit à une petite leçon sur les Éléments d'Euclide et le cinquième postulat, lequel est violé dans la géométrie sphérique. Dans cette géométrie les « droites » deviennent des grands cercles, et la somme des angles d'un triangle est supérieure à 180 degrés.

Cette géométrie a servi de prélude à explorer la géométrie hyperbolique sur le disque et à suivre Escher dans sa quête de l'infini :

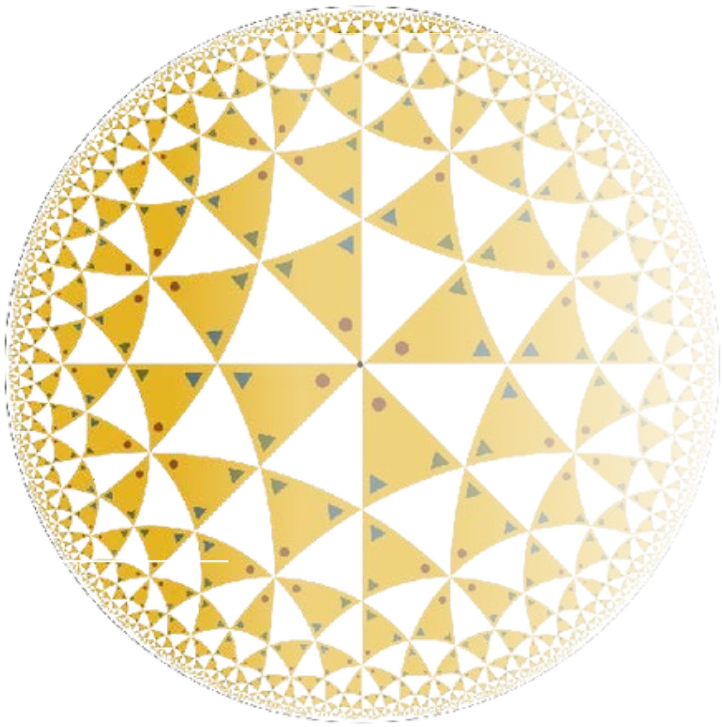
On peut se demander s'il y a ... beaucoup d'artistes plastiques qui éprouvent le désir de pénétrer, sur une simple feuille de papier ..., jusqu'au plus profond de l'infini ... », ce qui a amené l'artiste à composer la magnifique gravure « cercle limite III ».

Le public a été initié à cette dernière géométrie dans laquelle les « droites » sont des arcs de cercles ou des segments de droite orthogonaux à la frontière du disque.
La somme des angles d'un triangle hyperbolique est alors inférieure à 180 degrés.

Et pour paver le plan hyperbolique avec une tuile hyperbolique triangulaire, on utilise en guise de symétries des inversions par rapport à des côtés de triangles constitués d'arcs de cercles. Cette nouvelle géométrie dans laquelle les transformations préservent les angles permet un fascinant pavage infini s'accumulant sur la frontière du disque.

La somme des angles d'un triangle hyperbolique est alors inférieure à 180 degrés.

Christiane Rousseau
(Université de Montréal)

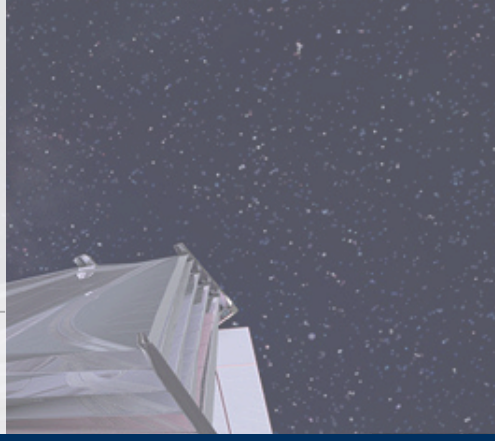


The Dutch artist Maurits C. Escher (1898-1972) was a draftsman, book illustrator, tapestry designer, and muralist, but his primary work was as a printmaker. After Escher left Italy in 1935, his interest shifted from landscape to something he described as "mental imagery," often based on theoretical premises. Escher also increasingly explored complex architectural mazes involving perspectival games and the representation of impossible spaces.

National Gallery of Art

Les premiers résultats du télescope James-Webb

René Doyon (Université de Montréal)



GRANDES CONFÉRENCES

Dans le cadre des 24 heures de science 2023, le CRM a accueilli René Doyon, directeur de l'Institut Trottier sur les exoplanètes et de l'observatoire du Mont-Mégantic. Sa conférence portait sur l'aventure du télescope James Webb depuis sa conception jusqu'aux premières images et résultats.

5 mai 2023

La conception et le lancement d'un télescope s'étalent sur plus de 20 ans et le télescope James-Webb a requis un budget de 10 milliards USD. Contrairement au télescope Hubble qui gravite à 590 km d'altitude, le télescope James-Webb est situé à 1 500 000 km de la Terre, au point de Lagrange L2. Il a la même vitesse angulaire de rotation que la Terre, si bien que la Terre lui cache le soleil et qu'il observe l'univers dos au soleil. À une telle altitude, aucune réparation et aucun ravitaillement ne sont possibles, et chaque détail doit être planifié à la perfection. Le miroir primaire du télescope est composé de 12 panneaux qui doivent se déployer dans l'espace, une fois le télescope arrivé en L2. Les lancement et déploiement du télescope se sont déroulés à la perfection, permettant même une économie de carburant qui sera utilisée pour prolonger la vie utile du télescope.

Le télescope contient quatre instruments. L'instrument canadien, dont le conférencier est le spécialiste est le Fine Guidance Sensor/ Near-Infrared Imager and Slitless Spectrograph (FGS/NIRISS). Le Fine Guidance

Sensor permet au télescope de garder le focus sur une même région de l'univers pendant une longue période de temps. Le Near-Infrared Imager and Slitless Spectrograph permet de capter la lumière infrarouge de longueur d'onde entre 0,8 et 5 microns.

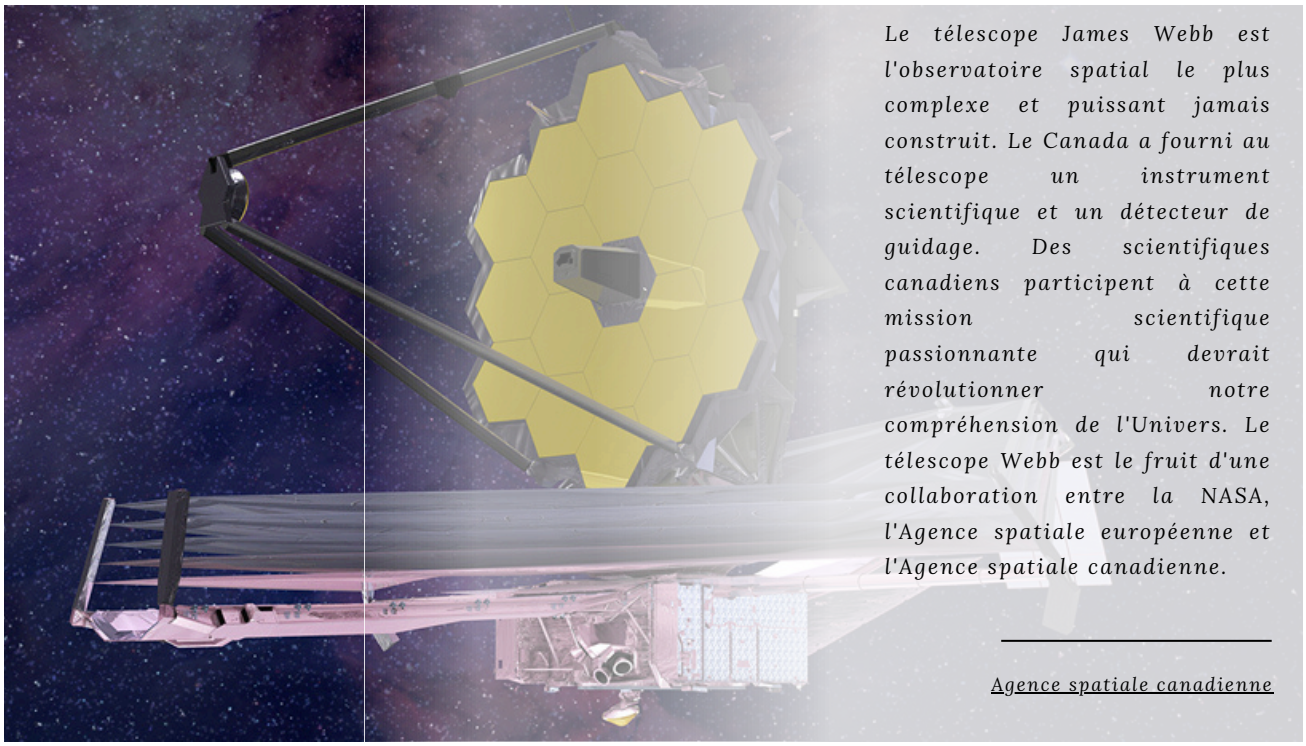
Le conférencier a illustré au public comment la lumière infrarouge permet de détecter des structures invisibles si on ne capte que la lumière visible. C'est cet instrument qui est utilisé pour la détection des exoplanètes. La détection d'une exoplanète est indirecte : elle se fait en observant que la lumière de l'étoile pâlit lors du passage de la planète. Mais, le spectrographe de l'instrument permet de faire beaucoup mieux. Comme il sépare la lumière en son spectre de fréquences, il permet de reconnaitre la signature des éléments chimiques de la planète et, en particulier, de détecter la présence d'eau.

De plus, il permet aussi de mesurer la vitesse de rotation de la planète autour de son étoile. Des méthodes statistiques sont nécessaires à l'analyse des données recueillies.

Plusieurs systèmes planétaires ont été observés récemment, certains avec une planète gazeuse, d'autres avec une petite étoile, et des systèmes avec des planètes orbitant plus ou moins près de leur étoile. Ce qui intéresse surtout les scientifiques, c'est la détection de planètes « habitables », c'est-à-dire où la température avoisine celle de la Terre et où il y a présence d'eau.

En primeur, le public, fasciné, a eu droit à l'annonce de la découverte d'une planète tempérée de la taille de la Terre en orbite autour de la naine froide. Cette planète a une température de 300-400K permettant la condensation de l'eau.

Christiane Rousseau
(Université de Montréal)



Le télescope James Webb est l'observatoire spatial le plus complexe et puissant jamais construit. Le Canada a fourni au télescope un instrument scientifique et un détecteur de guidage. Des scientifiques canadiens participent à cette mission scientifique passionnante qui devrait révolutionner notre compréhension de l'Univers. Le télescope Webb est le fruit d'une collaboration entre la NASA, l'Agence spatiale européenne et l'Agence spatiale canadienne.

Agence spatiale canadienne

Une approche stratégique à l'atteinte de la carboneutralité

Normand Mousseau (Université de Montréal)

GRANDES CONFÉRENCES

La semaine de la culture scientifique 2023 se tenait sous le thème de l'énergie. C'est dans ce cadre que le CRM a accueilli Normand Mousseau, directeur de l'Institut de l'énergie Trottier. Le thème de sa conférence portait sur les défis pour le Canada d'adopter une stratégie visant l'atteinte de la carboneutralité.

21 Septembre 2023

La conférence présentait le travail de toute une équipe sur une modélisation de l'ensemble du secteur énergétique au Canada dans le but d'identifier des trajectoires optimales vers la carboneutralité. Le calcul s'appuie sur une connaissance de la part des différents secteurs dans les GES émis au pays. Les trajectoires sont optimisées sous différents scénarios, le premier étant l'absence de contrainte de réduction des GES, et les autres, différents objectifs de réduction pour 2030, 2050 ou 2060. Il en ressort que la séquestration du carbone et la sobriété énergétique ne suffiront pas à atteindre les objectifs et qu'il faut absolument réduire la production de GES et faire une transition vers l'énergie renouvelable. La bonne nouvelle est que celle-ci est de moins en moins chère.

Au Canada, les émissions directes des citoyens ne comptent que pour 22% du total des émissions et il faut mettre à contribution l'industrie pétrolière et gazière, les industries lourdes, le secteur commercial et le secteur électrique.

Le secteur des transports est difficile à décarboner, surtout le transport lourd. Le conférencier a présenté le rôle de l'Accélérateur de transition qui met en réseau les chercheurs, experts et décideurs pour faciliter l'élaboration de politiques énergétiques visant la carboneutralité et basées sur les données probantes. Il a ensuite exploré les stratégies ressortant des analyses, tant à l'échelle canadienne qu'à l'échelle québécoise. Alors, qu'il est trop tard pour rencontrer les objectifs de 2030, il a insisté sur l'urgence de planifier la manière de rejoindre ceux de 2050. Tous les secteurs doivent être mis à contribution.

La conférence, captivante, a soulevé de nombreuses questions et suscité des débats animés.

Christiane Rousseau
(Université de Montréal)

CRM NIRENBERG LECTURES IN GEOMETRIC ANALYSIS

The 2023 Lectures by Misha Bialy & Sergei Tabachnikov

OCTOBER 16-20, 2023

NIRENBERG LECTURES

The lectures of the 2023 Nirenberg series were delivered at the CRM by Professor Misha Bialy (Tel Aviv University) and Professor Sergei Tabachnikov (Penn State University) during the week of October 16 - October 20, 2023. The main topics of this series of four lectures were mathematical billiards, including questions of integrability.

Professor Bialy is an internationally renowned expert in billiard dynamics, completely integrable systems, Hamiltonian mechanics, and related areas of symplectic topology. His work includes a celebrated result from the 1990s on billiards without conjugate points, collaboration with Leonid Polterovich on geodesics in Hofer's geometry, and a recent breakthrough paper with Andrey Mironov on the Birkhoff-Poritsky conjecture.

Professor Tabachnikov is renowned for his research on mathematical billiards, completely integrable systems and projective differential geometry. He has obtained fascinating results on non-standard billiard and is also a well-known author of books and expository texts in mathematics. He is a Fellow of the American Mathematical Society and Deputy Director Emeritus of the ICERM at Brown University, as well as Editor-in-Chief of Arnold Mathematical Journal, co-Editor-in-Chief of the Mathematical Intelligencer, and Associate Editor of the Journal of Experimental Mathematics.

The series was started by Misha Bialy with two lectures focused on integrability and rigidity in billiards. His first lecture, aimed at a general mathematical audience, provided an overview of recent progress around the Birkhoff-Poritsky conjecture for convex billiards in the plane. It states that the only integrable convex billiards are ellipses. He explained his approach to this conjecture, based on extending the E. Hopf type rigidity method from Riemannian geometry to Twist symplectic maps and billiards. In particular, he discussed a criterion for local maximality of billiard orbits in terms of Jacobi fields. In his second lecture, Bialy explained how to construct non-standard generating functions for Birkhoff billiards and for Outer billiards and discussed further ramifications of the discrete Hopf method: a rigidity result for centrally symmetric Birkhoff billiards and for Outer billiards, and an effective version of the Birkhoff-Poritsky conjecture.

NIRENBERG LECTURES

The last two lectures were delivered by Sergei Tabachnikov. His first lecture introduced the audience to the classic Dowker theorem, which states that the minimal areas of n-gons circumscribed about an oval form a convex sequence. He showed the relation of this, and a number of similar geometric inequalities, to billiard-like maps: they are consequences of Mather's inequality for the minimal action of monotone twist maps. He discussed the four Dowker-style inequalities for inscribed /circumscribed polygons of maximal/minimal areas/perimeters are related to four billiard-like maps, which are subjects of active research. He also mentioned applications to magnetic billiards, wire billiards, and further billiard-like systems. His second lecture, aimed at a general mathematical audience, explained remarkable consequences of the complete integrability of billiards inside an ellipse. He explained the Ivory lemma asserting that the diagonals of a curvilinear quadrilateral made by arcs of confocal ellipses and hyperbolas are equal, and other applications like the Poncelet Porism and the Poncelet Grid theorem.

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.

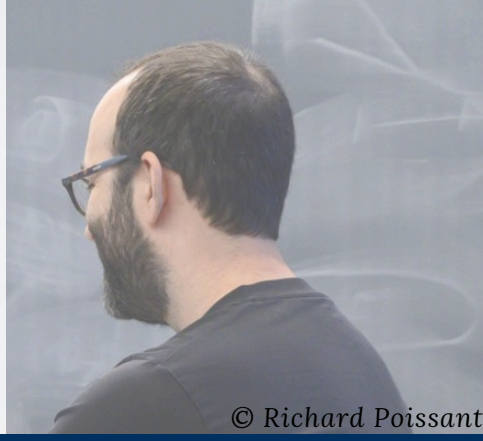
- **Organizers**

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

PRIX
ANDRÉ AISENSTADT

Naked Singularities for the Einstein Vacuum Equations

Yakov Shlapentokh-Rothman
(University of Toronto)



© Richard Poissant

PRIX ANDRÉ AISENSTADT

General Relativity and the Cauchy problem

In classical General relativity, in the absence of matter, the universe is modeled as a 4 dimensional Lorentzian manifold (M,g) which satisfies the Einstein vacuum equations Ric(g) = 0. Here Ric denotes the Ricci curvature of the metric g. Recall that g being Lorentzian means that at each point p of the manifold M there exist local coordinates (x^0,x^1,x^2,x^3) with respect to which : $g = -(dx^0)^2+ (dx^1)^2+ (dx^2)^2+ (dx^3)^2$

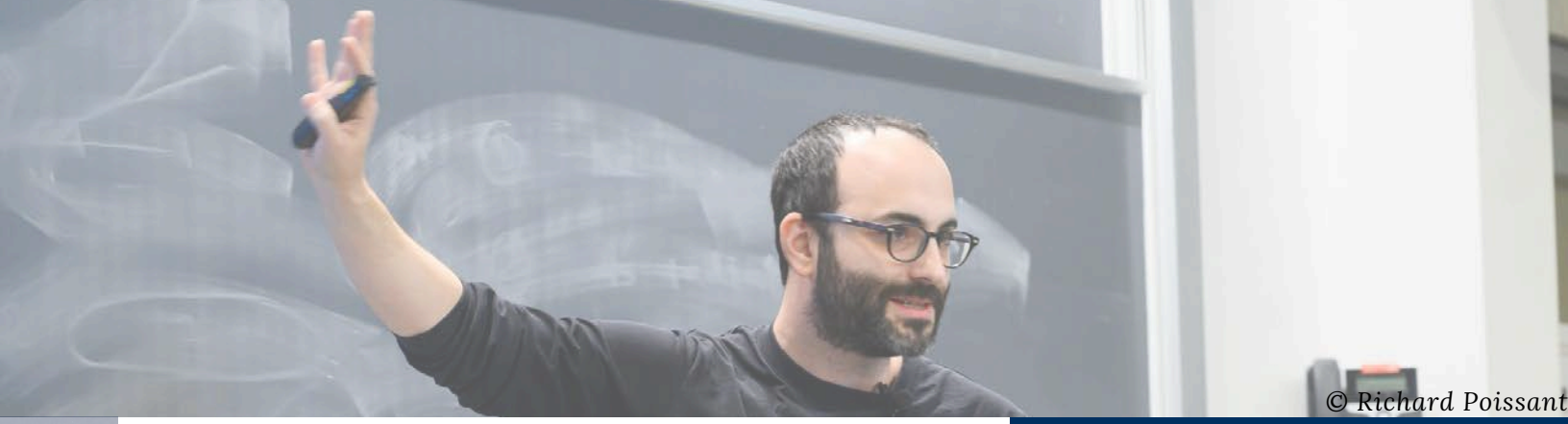
In particular, a given vector X at a point of M may either have a negative, zero, or positive value for g(X,X) in which case we say that X is timelike, null, or spacelike. A vector is causal if it is null or timelike. A basic physical constraint is that "point particles" must move along a *causal curve*, that is, a curve with causal tangent vectors. The set of null geodesics emanating from a point locally form a so-called *light cone*; all causal curves must always move inside of their corresponding light cones.

> Of fundamental importance for General relativity is the existence of an initial value formulation or *Cauchy problem* for the Einstein vacuum equations.

Namely, given a three dimensional Riemannian manifold (N,h) and a symmetric (0,2)-tensor k on N satisfying the so-called "constraint equations," a famous result of Choquet-Bruhat and Geroch shows that there exists a unique maximal globally hyperbolic develo-pment (M,g). This will be a four dimensional Lorentzian mani-fold solving the Einstein vacuum equations and where (N,h) embeds as a Riemannian submanifold with second fundamental form k. We refer to the triple (N,h,k) as an "initial data set" corresponding to (M,g). A key point in the proof of this result is that in a suitable coordinate system, the Einstein vacuum equations become a system of quasilinear wave equations for the metric.

The weak cosmic censorship conjecture

General relativity is an enormously successful theory. Nevertheless, there remain fundamental unresolved conceptual issues. One of the simplest to explain is the following: From our experience with many different solutions, such as the famous Schwarzschild black hole, we expect the occurrence of severe singularities where a classical description of spacetime must break down. Nevertheless, we would like to use other parts of these spacetimes to



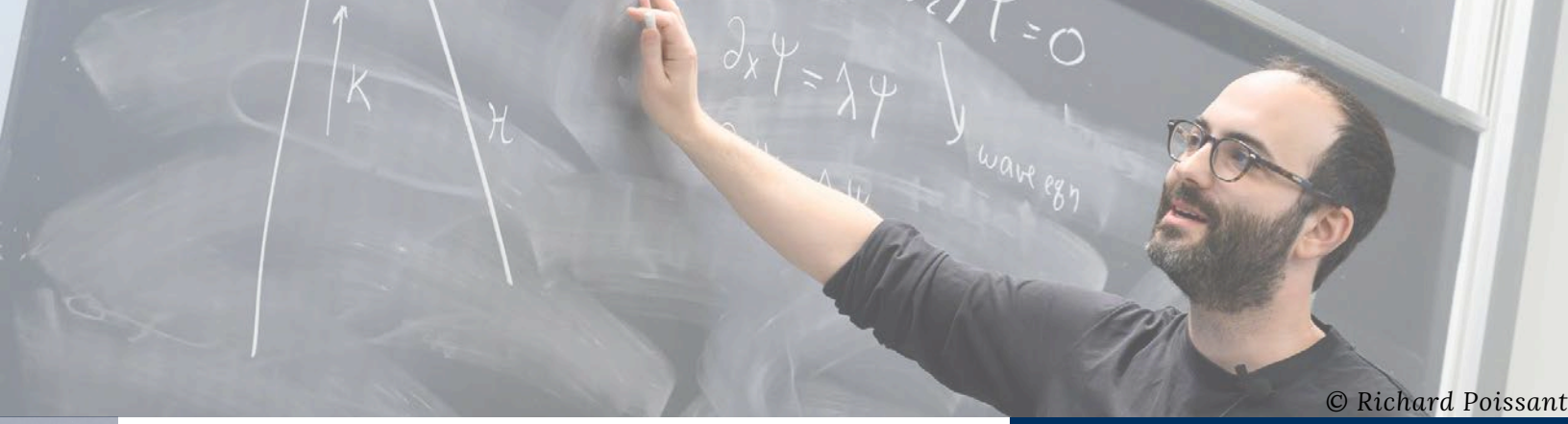
© Richard Poissant

derive physical consequences. Should we be worried that some modification of General relativity which is necessary at the singularity will also lead to changes in the "good'" part of the solution? Penrose's famous weak cosmic censorship conjecture suggests a way out of this conundrum, at least in the case of asymptotically flat spacetimes, which are spacetimes whose initial data sets (N,h,k) converge to the trivial Euclidean metric initial data set ($\mathbb{R}^3$,e,0) when compared on the complement of larger and larger compact sets.

Conjecture (Penrose's weak cosmic censorship conjecture original version): If a spacetime (M,g) arising from an asymptotically flat initial dat set possesses a singularity ,then the spacetime (M,g) may be partitioned into a "black hole region" and a regular "exterior region.'' The singularities will all be contained in the black hole region, and the black hole region is causally disconnected from the exterior region. This means that future oriented causal curves starting in the black hole region can never enter the exterior region. If the weak cosmic censorship conjecture holds true, then one knows there will always exist a good part of the spacetime which need not interact with singular part! A spacetime with a singularity that is not contained in a black hole region is called a naked singularity.

Constructing Naked Singularities

In a very influential sequence of works in the 1990s Christodoulou studied the analogue of the weak cosmic censorship for the spherically symmetric Einstein-scalar field system. This is a modification of the Einstein equations where one introduces an extra unknown function which satisfies the wave equation. The key benefit of this system is that one can study it in spherical symmetry and there exists nontrivial solutions (unlike the case of vacuum where Birkhoff's theorem implies that all spherically symmetric vacuum solutions to the Einstein equations are locally isometric to one of the one parameter family of Schwarzschild spacetimes). The two key results of Christodoulou for this system are that (1) There do exist naked singularity solutions! (2) Generic perturbations of a naked singularity lead to a spacetime containing a black hole. In view of Christodoulou's results the modern formulation of the weak cosmic censorship conjecture now adds the requirement that the spacetime *be generic*.



© Richard Poissant

While Christodoulou's work is very impressive, the techniques used for both of the above results are intimately tied to the assumed spherical symmetry. For many years there was no progress on even the analogous construction of naked singularities for the Einstein vacuum equations. However, recently, in a combination of two works, analogues of Christodoulou's construction for the Einstein vacuum equations have finally been constructed:

> Theorem (Rodnianski – S 2023, S 2022) There exist naked singularity solutions for the Einstein vacuum equations.

A key role in the above theorem is the introduction of a fundamentally new type of self-similarity for the Einstein vacuum equations which we call "twisted self-similarity."

There remain many important open questions about naked singularities. We list two immediate ones concerning the theorem above:

1| Both Christodoulou's and the vacuum naked singularities have initial data which is only $C^{1,\alpha}$ Is it possible to construct naked singularities C^2 with or smooth initial data?
2| What happens when you perturb the initial data for the vacuum naked singularity solutions? Does the answer depend on the regularity of the perturbation?

Statistical learning via algebraic constraints

Elina Robeva
(University of British Colombia)

© Richard Poissant

PRIX ANDRÉ AISENSTADT

Much of my research is on designing methods for statistical inference in models that impose complex dependencies among the observed random variables. Such models often exhibit rich algebraic, combinatorial, and geometric structure, hence, much of my work falls within the field of *algebraic statistics* [Sul21]. Below I discuss tensor decomposition, graphical models, and causal inference.

Tensor decomposition and graphical models

A *tensor* is a multidimensional array of numbers. While matrices are tensors with two *modes* – rows and columns, tensors can have 3 or more modes. Matrix decompositions like the singular value decom-position, eigendecomposition, LU decomposition, and others have been very useful in applications, and can give good representations for low-rank matrices.

One way to generalize these decompositions to tensors is the *CP decomposition* [Hit27]. It expresses a tensor as a sum of *rank-one* tensors, where a rank-one tensor is an outer product of vectors (Figure 1).

CP decomposition has numerous applications [AGH+14, KB09]. For instance, it often helps uncover information about a hidden variable or some type of mixing when applied to either a raw data tensor or a moment/cumulant tensor. However, finding the CP decomposition of a generic tensor is an NPhard problem [HL13]. This has sparked interest in finding classes of tensors for which finding the decomposition can be done efficiently.

A tensor is *orthogonally decomposable* [AGH+14, Rob16] if it has a CP decomposition whose vectors are orthonormal. As opposed to general tensors, orthogonally decomposable tensors can be decomposed efficiently for example via the tensor power method [AGH+14, ZG01].

In joint work with Boralevi, Draisma, and Horobeţ [BDHR17], we give a complete algebraic characterization of the set of orthogonally decomposable tensors. For instance, we show that a symmetric tensor is orthogonally decomposable, if when it is multiplied with itself along one mode, the resulting tensor is symmetric.

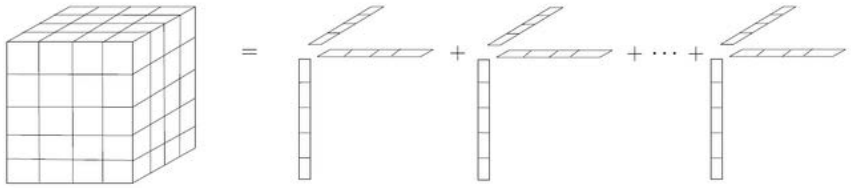


Figure 1: A $5 \times 4 \times 4$ tensor and a pictorial representation of its CP decomposition.

© Richard Poissant

PRIX ANDRÉ AISENSTADT

In addition to being hard to decompose tensors, it is also NP-hard to find even one eigenvector of a general tensor [HL13]. However, in [Rob16], I show that this is not the case for orthogonally decomposable tensors.

> In particular, the eigenvectors of an orthogonally decomposable tensor can be described with a simple formula in terms of the vectors in the decomposition, and, moreover, can be found efficiently.

The challenge with orthogonally decomposable tensors, however, is that their rank is very low. More precisely, an $n \times n \times \cdots \times n$ (d times) orthogonally decomposable tensor has rank at most n, while the rank of a generic tensor of this size is of order n^{d-1} [Lan12]. Therefore, a random tensor will be orthogonally decomposable with probability 0. In joint work with Tommi Muller and Konstantin Usevich [MRU22], we give sufficient conditions on the vectors in the decomposition of a tensor so that they are eigenvectors of the tensor and, thus, its CP decomposition can be found via the tensor power method.

There are many more types of tensor decompositions apart from CP. Corresponding to any (hyper) graph, one can define a *tensor network* [Or9], which decomposes a tensor according to the graph structure. Tensor networks are used in quantum physics to give an efficient representation of quantum states, but also in machine learning, where they can give an efficient representation of a data tensor. In joint work with Anna Seigal [RS18], we have shown that tensor network decompositions are dual (in a hypergraph sense) to graphical models – widely used statistical models which decompose a probability distribution according to the cliques of a graph and depict conditional independence relationships among the random variables [Lau96].

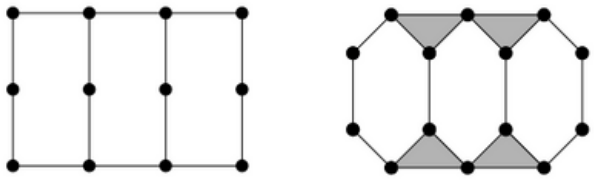


Figure 2: The Matrix Product State (MPS) tensor network on four states contracted with itself (left). Its dual graphical model (right) [RS18].

© Richard Poissant

Tensor decomposition and causal inference

One of the main problems in causal inference aims to recover causal relationships among observed random variables. I have studied this problem in the setting when interventions (e.g., rando-mized control trials) are not possible. In this case we say that we have *observational data*.

Figure 3. A directed graph (left) and the structural equations corresponding to it (right.)

To depict causal effects, we place each random variable at a vertex of a directed graph. A directed edge between two variables signifies a direct causal effect. A structural causal model with a given directed graph stipulates that each X_i variable is a function of its direct causes and random noise ε_i.

Given samples from the random vector X arising from such a model, our goal is to identify. One such assumption is that the structural equations are linear, the graph is acyclic, and the noise terms ε are non-Gaussian [SHHK06]. Non-Gaussianity gives more information about the model (thereby allowing us to recover the graph) because a non-Gaussian random vector has meaningful higher-order moment tensors.

One can show that the graph can be recovered from the second and third order moments of the distribution of X, approximations of which can be observed from data. This fact has spurred active developments that have led to effective and scalable model selection algorithms applicable to a variety of different settings (such as latent variables and high dimensions) [SHHK06, SIS+11, WD20, LRW21, WD23] (see also the recent book [Shi22]). In fact, CPdecomposition applied to the third-order moment tensor of the random vector X recovers precisely the coefficients in the linear structural equations, which in turn encode the graph structure.

In our recent work in this area, we have shown that the vanishing of certain moments corresponds to an absence of a common cause [RS21], used this characterization for an improved graph recovery algorithm in the case of latent variables [LRW21], we have given a complete description of the polynomial relationships among second and third order moments of the random vector X when the graph is a polytree [ADG+23]. In current work, we characterize all relationships among the second and third moments for any direc- ted acyclic graph and use it to find confidence intervals for the causal ordering [GR24], we devise efficient algorithms for graph recovery based on moment relationships in the presence of directed cycles [DGLNR24] as well as latent

© Richard Poissant

variables [SRD24].

The moment varieties arising from such models are cut out by low-rank conditions on certain matrices whose entries are high order moments of the random vector X, and have beautiful combinatorial and algebraic structure.

- **References**

[ADG+23] Carlos Am´endola, Mathias Drton, Alexandros Grosdos, Roser Homs, and Elina Robeva. Third-order moment varieties of linear non-Gaussian graphical models. Information and Inference: A Journal of the IMA, 12(3):1405–1436, 04 2023.

[AGH+14] Anima Anandkumar, Rong Ge, Daniel Hsu, Sham Kakade, and Matus Telegarski. Tensor decomposition for learning latent variable models. Journal of Machine Learning Research, 15:2773–2832, 2014.

[BDHR17] Ada Boralevi, Jan Draisma, Emil Horobet¸, and Elina Robeva. Orthogonal and unitary tensor decomposition from an algebraic perspective. Israel Journal of Mathematics, 222:223–260, 2017.

[DGLNR24] Mathias Drton, Marina Garrote-Lopez, Niko Nikov, and Elina Robeva. Model selection for linear non-gaussian causal models with disjoint cycles. In preparation, 2024+.

[GR24] Cole Gigliotti and Elina Robeva. Second and third-order moment varieties for linear non-gaussian acyclic causal models. In preparation, 2024+.

[Hit27] F. L. Hitchcock. The expression of a tensor or a polyadic as a sum of products. J. Math. Phys., 6:164–189, 1927.

[HL13] Christopher Hillar and Lek-Heng Lim. Most tensor problems are np-hard. Journal of the ACM, 60(45):1–39, 2013.

[KB09] Tamara Kolda and Brett Bader. Tensor decompositions and applications. SIAM Review, 51(3):455–500, 2009.

[Lan12] JM Landsberg. Tensors: Geometry and Applications, volume 128. Graduate Studies in Mathematics, 2012.

[Lau96] Steffen Lauritzen. Graphical models. 1996.

[LRW21] Yiheng Liu, Elina Robeva, and Huanqing Wang. Learning linear non-Gaussian graphical models with multidirected edges. J. Causal Inference, 9(1):250–263, 2021.

[MRU22] Tommi Muller, Elina Robeva, and Konstantin Usevich. Robust eigenvectors of symmetric tensors. SIAM Journal on Matrix Analysis and Applications, 43(4), 2022.

[Or9] Rom´an Or´us. Tensor networks for complex quantum systems. Nature Reviews Physics, 1(9):538–550, 2019.

© Richard Poissant

[Rob16] Elina Robeva. Orthogonal decompositio of symmetric tensors. SIAM Journal on Matrix Analysis and Applications, 37(1), 2016.

[RS18] Elina Robeva and Anna Seigal. Duality of graphical models and tensor networks. Inforuмation and inference: a journal of the IMA, 8(2):273–288, 2018.

[RS21] Elina Robeva and Jean-Baptiste Seby. Multi-trek separation in linear structural equation models. SIAM Journal on Applied Algebra and Geometry, 5(2):278–303, 2021.

[SHHK06] Shohei Shimizu, Patric. O. Hoyer, Aapo Hyv¨arinen, and Antti" Kerminen. A linear non-gaussian acyclic model for causal discovery. Journal of Machine Learninig Research, 7:2003–2030, 2006.

[Shi22] Shohei Shimizu. Statistical causal discovery: LiNGAM approach. SpringerBriefs in Statisuтics. Springer Japan, Tokyo, [2022] ©2022. JSS Research Series in Statistics.

[SIS+11] S. Shimizu, T. Inasumi, Y. Sogawa, A. Hyv¨arinen, Y. Kawahara, Washio. T., P. O. Hoyer, and K. Bollen. Directlingam: a direct method for learning a linear non-gaussian structural equation model. Journal of Machine Learning Research, 12:1225–1248, 2011.

[SRD24] Daniela Schkoda, Elina Robeva, and Mathias Drton. Causal discovery for linear nonuugaussian models in the presence of latent variables. In preparation, 2024+.

[Sul21] Seth Sullivant. Algebraic statistics. Graduate Studies in Mathematics. American Matheuмatical Society, 2021.

[WD20] Y. Samuel Wang and Mathias Drton. High-dimensional causal discovery under nonuGaussianity. Biometrika, 107(1):41–59, 2020.

[WD23] Y. Samuel Wang and Mathias Drton. Causal discovery with unobserved confounding and non-Gaussian data. J. Mach. Learn. Res., 24:Paper No. [271], 61, 2023.

[ZG01] T. Zhang and G. Golub. Rank-one approximation to high order tensors. SIAM Journal on Matrix Analysis and Applications, 23:534–550, 2001.

CRM
POST-DOCS

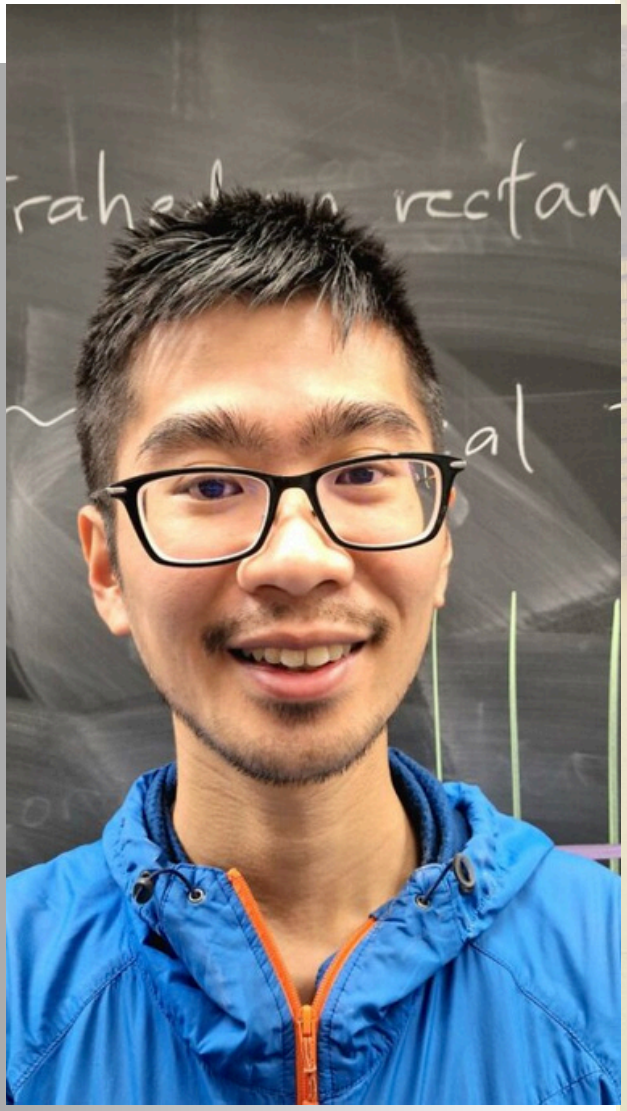
POSTDOCTORAL FELLOWS

CRM - ISM

Chi Cheuk Tsang

PhD : University of California, Berkeley

Supervision: Duncan McCoy (UQAM)



Geometry and topology

My research is in low-dimensional topology. I think about mapping classes of surfaces, and flows and foliations on 3-manifolds. I specialize in using combinatorial, finite-type tools to study these objects. One instance of this is the theory of correspondence between veering triangulations and pseudo-Anosov flows, which I helped develop and showed applications of in my PhD thesis.

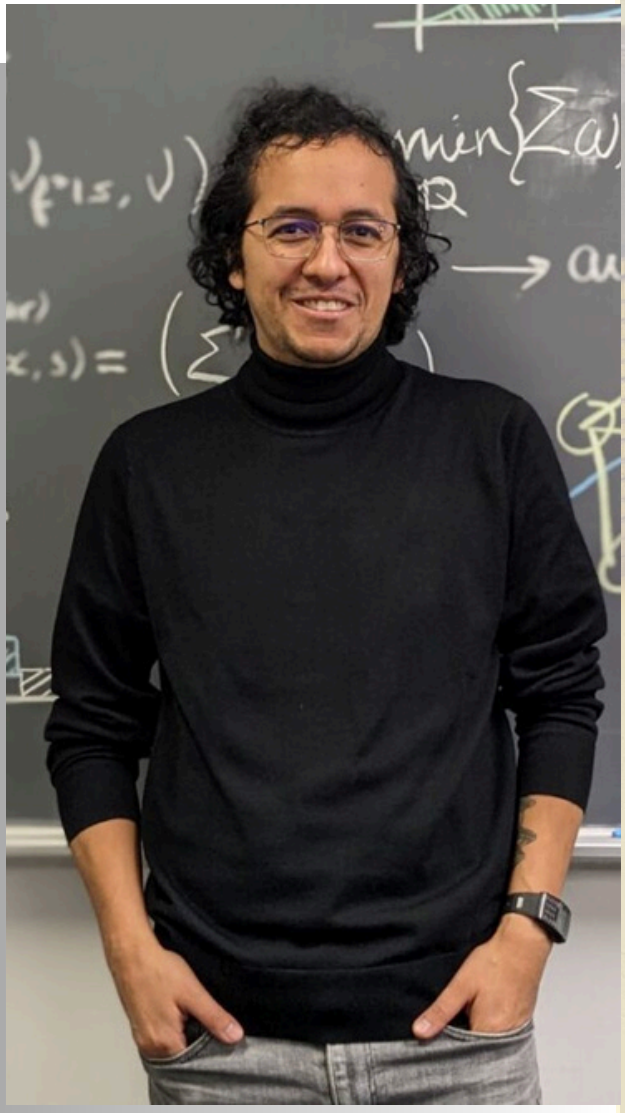
POSTDOCTORAL FELLOWS

CRM
-ISM

Dante Mata-Lopez

PhD : Mathematics Research Center, CIMAT

Supervision: Hélène Guérin (UQAM), Jean-François Renaud (UQAM), Alexandre Roch(UQAM), Clarence Simard (UQAM)



Actuarial and Financial Mathematics, Probability: Theory and Applications

My main interest lies in the study of Levy Processes and Diffusions, as well as their application in Stochastic Control and Optimal Stopping problems. In particular, I am interested in problems that arise from applications in Finance, Actuarial Science and Risk Theory. A classical problem in this area is the De Finetti dividend maximization problem, where one models the evolution of the surplus of an insurance company with a Levy process, and collects dividends from the surplus. In these type of dividend maximization problems we have a lot of flexibility regarding the probabilistic behaviour of the surplus, the dividend decision rules, the type of ruin times considered, just to name a few. Each of these considerations or generalisations leads to interesting studies and proposals of possible candidate optimal strategies, as well as the study of Fluctuation Theory for Levy Processes and Diffusions, i.e., the study of exit times, and their related functionals.

POSTDOCTORAL FELLOWS

CRM - LAVAL

Ryan O'Loughlin

PhD : University of Leeds

Supervision: Thomas Ransford, Javad Mashreghi (Laval)

Functional analysis, operator theory and related fields

My research mostly focuses on studying concrete operators, such as Toeplitz and truncated Toeplitz operators. I am particularly interested in investigating how to model a seemingly larger class of operators through the use of concretely defined operators. This model operator approach has its roots in Sz.-Nagy-Foias model theory for Hilbert space contractions, which realises certain contractions as truncated Toeplitz operators. My recent research interest is Crouzeix's Conjecture, which bounds the norm of a polynomial applied to an operator in terms of the numerical range of the operator. For decades, mathematicians from various fields have been trying to sharpen the bound appearing in Crouzeix's Conjecture.

POSTDOCTORAL FELLOWS

CRM - uOttawa

Zaoli Chen

PhD : Cornell University

Supervision: Rafał Kulik (uOttawa)

Probability Theory and Stochastic Processes

My research interest is extreme value theory of dependent random variables. For the probabilistic aspect, I have been working on long-range dependent processes whose constructions are based on dynamic systems over infinite measure spaces. For the statistical aspect, I have been analyzing different block estimators under the Peak-over-Threshold framework. My research combines extreme value theory with other fields of stochastics, for example, Markov chains and random walks.

EQUITY, DIVERSITY & INCLUSION (EDI)

CELEBRATION OF INTERNATIONAL WOMEN'S DAY AT THE CRM

MAY 12, 2023

EQUITY, DIVERSITY & INCLUSION (EDI)

The CRM's EDI committee invited mathematicians and statisticians who identify themselves as women (students, postdocs or professors, and their friends), for a casual get-together honouring International Women's Day and women in science.

This informal gathering held between 4 and 6 pm in the Maurice Labbé lounge of Université de Montréal was well attended with more than 20 participants at its peak.

Among distinguished guests, we had Professor Vasilisa Shramchenko (Sherbrooke) who also gave the colloquium on Friday, March 10th in a continuation of this celebration, Professor Christiane Rousseau (UdeM) who publicized outreach activities and short videos featuring the last four Fields medallists recorded for the upcoming 3.14/Pi Day, and Professors Linan Chen and Jessica Lin (McGill) who talked about recent challenges of graduate programs in mathematical sciences in Montreal, and at McGill University in particular. All conversations were held informally and what we illustrated here is by no means exhaustive. Participants noted the usefulness of such meetings for connecting with each other and sharing various professional ideas or news.

We should particularly note an enthusiastic group of graduate students from UQAM, a category of participants we especially hoped to target for this event.

A couple of postdocs and instructors were also in attendance. We will aim to attract even more young researchers at future gatherings.

The scientific colloquium delivered by Professor Vasilisa Shramchenko on Friday, March 10, titled *Some expected and unexpected applications of Riemann surface theory in mathematical physics*, was well attended and prompted a lively discussion afterwards among the people in the audience.

In all, we were pleasantly surprised to see such a positive response to this initiative and we will look into creating more opportunities to bring together members of our mathematical community in a similar setting.

LES FEMMES DE LA STOCHASTICITÉ

12 MAI 2023

EQUITÉ, DIVERSITÉ & INCLUSION (EDI)

Le but de l'événement était de regrouper quatre femmes du milieu académique dans des domaines connexes aux probabilités et à la statistique, afin qu'elles discutent de la place des femmes dans leur milieu professionnel ainsi que des défis particuliers auxquels elles font face dans leur carrière. Les quatre femmes participant à la discussion étaient :

- Raluca Balan, professeure titulaire, Université d'Ottawa;
- Debbie J. Dupuis, professeur titulaire, HEC Montréal;
- Dena Firoozi, professeure adjointe, HEC Montréal;
- Vanessa McNealis, étudiante au doctorat, McGill University.

Les domaines des probabilités, de la statistique, de la biostatistique et des mathématiques financières étaient représentés.

L'événement a débuté par une présentation soulignant le travail de quelques femmes s'étant illustrées dans les domaines des probabilités et de la statistique au cours du 20e siècle au Canada et à l'international. Cette présentation fut donnée par Shirin Golchi, professeure adjointe à l'Université McGill.

Les questions posées pendant la table ronde portaient sur les expériences de femmes dans les différents aspects de leur travail (enseignement, recherche, participation à des conférences).

Le « syndrome de l'imposteur » ainsi que la conciliation travail-famille ont été discutés. Parmi les points relevés, on note le désir d'un changement dans l'environnement de travail afin de donner plus confiance aux femmes, la nécessité de faire preuve d'une grande organisation et d'établir ses limites. Le public était également invité à poser des questions, ce qu'il a fait lors de la discussion sur l'équilibre entre la vie professionnelle et personnelle.

Ces interventions ont mené à des échanges intéressants par rapport aux attentes que le milieu a envers les parents revenant de congé parental. L'événement a duré 90 minutes et les questions prévues n'ont pas toutes été posées.

INTERNATIONAL WOMEN IN MATH DAY – FILM PROJECTION AND PANEL DISCUSSION

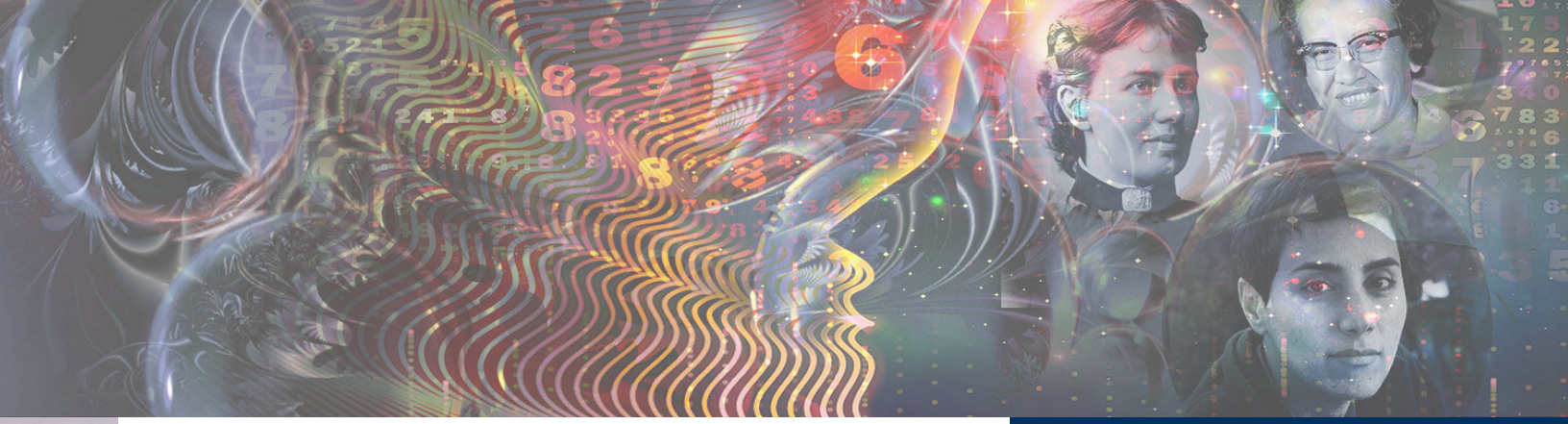
MAY 13, 2023

EQUITÉ, DIVERSITÉ & INCLUSION (EDI)

On May 13, 2023, the Department of Mathematics and Statistics of Concordia University played host to the celebration of International Women in Mathematics Day. The event was a large success, with a diverse audience of about 70 people gathering to honour the life and accomplishments of Maryam Mirzakhani, the first woman and Iranian to receive the Fields Medal. Attendees were captivated by a screening of the documentary "Secrets of the Surface: The Mathematical Vision of Maryam Mirzakhani," directed by George Csicsery.

The film showcased Mirzakhani's extraordinary journey and impact on the field of mathematics, while also making complex mathematical concepts acces-
sible to all using animated sequences and visual explanations.

The event, which took place in the de Sève Cinema, located in the McConnell Building on Concordia's downtown campus, opened with introductions by Cody Hyndman, Chair of the Department of Mathematics and Statistics at Concordia University, and Elizabeth Bloodgood, Interim Associate Dean of Faculty Affairs and Inclusion. Following the film projection, the four panelists listed above engaged in a thought-provoking conversation, sharing their experiences, challenges, and triumphs as women in the mathematical sciences. It was evident from the discussion that while diverse and sometimes non-traditional paths brought these women to their chosen careers in mathematics or statistics, what they had in common was a passion and talent for the subject and a determination to work hard, solve problems and overcome difficulties. This passion, talent and determination to solve problems was also what they admired in Maryam Mirzakhani, and her story, both of triumph and tragedy, brought out some emotions. Other points that were raised in the discussion were the need for increased appreciation of the importance of mathematics in the general public, so that children can be encouraged to study it by their parents and schools, improving the level of mathematics education across the board. At the same time, students who may have not benefitted from an early exposure to mathematics may still discover its beauty and should be supported in their efforts. Graduate students, especially international also need increased financial support. And finally, at the faculty level, women are being overburdened with admini-strative and organizational duties and should be allowed more time to pursue their research. The panelists' comments elicited sympathetic reactions and sometimes laughter from the audience, and the evening ended with several questions and interesting comments from members of the audience.



The activity exemplified the spirit of International Women in Mathematics Day, as it not only honored Mirzakhani's ground-breaking achievements but also provided a platform to promote gender inclusivity and encourage more women to pursue careers in the mathematical sciences.

- **Panelistes / Panelists**

Saeedeh Nasrin Jamali (MSc student, Department of Mathematics and Statistics, Concordia University)
Dominique Maldague (Postdoctoral Fellow, Massachusetts Institute of Technology
Lea Popovic (Professor, Department of Mathematics and Statistics, Concordia University)
Vasilisa Shramchenko (Professor, Université de Sherbrooke)

- **Organizers**

Galia Dafni (Concordia University)
Christopher Plenzich (Concordia University)

EN AVANT MATH !

ACTIVITÉS DU CRM DANS LE CADRE DU PROJET EN AVANT MATH! 2023-2024

2023-2024

Le Centre de recherches mathématiques (CRM) et le Centre interuniversitaire de recherche en analyse des organisations (CIRANO) sont responsables d'une initiative nationale, En avant math!, pour promouvoir les mathématiques et accroître la numératie grâce à une subvention accordée par le ministre des Finances pour 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».

Cette année, les activités du CRM dans le cadre de ce projet se déploient en deux volets. Un premier vise à soutenir des activités sur le terrain.

Un appel à projet s'est terminé en juin 2023 et cinq projets ont été retenus :

- F. Gourdeau U. Laval Soutien aux activités de l'Association québécoise des jeux mathématiques
- J-M De Koninck, U Laval, Soutien aux activités Sciences et mathématiques en action.
- Line Légaré, Collège de Maisonneuve, Projet Code tes maths
- N. Bisaillon, U de M, Activités auprès des parents, grands-parents et enseignantes pour faire « vivre » les capsules vidéo
- V. Houle, UQAM, Projet « des mathématiques inspirantes dès le premier cycle du primaire ».

En plus de poursuivre le soutien d'activités sur le terrain, le CRM a lancé un appel à projets pour le développement de formations courtes pour le rehaussement du niveau en maths et en statistique des travailleurs dans des domaines cruciaux. Le but principal de ce projet est de développer des formations courtes constituées de capsules vidéo, *trois capsules vidéo d'environ 10 à 15 minutes chacune par thème retenu, qui vont être disponibles en ligne et libres de droits d'auteur*. Ce concours s'est terminé le 1er septembre 2023. Deux projets ont été retenus, celui de l'équipe de Morgan Craig de l'Université de Montréal et celui de l'équipe de Bouchra Nasri également de l'Université de Montréal. La production de ces capsules vidéo a démarré avec le soutien de la SOFAD (Société de formation à distance des commissions scolaires du Québec).

CRM DISTINGUISHED RESEARCH SCHOLAR

WHAT FUNDAMENTAL CHANGES WILL COMPUTERS WREAK ON MATHEMATICAL RESEARCH? WILL THESE ALTER WHAT WE BELIEVE AND WHO WE ARE?

Andrew Granville
(Université de Montréal)

© Richard Poissant

CRM DISTINGUISHED RESEARCH SCHOLAR

When a computer asserts that something is proven, should you believe it? Can a computer be the ultimate authority to certify that a mathematical argument is completely correct? Can it be independent and truly objective? On what basis can you trust that the computer has fully verified a proof?

The question of when one should believe something to be true, and on what basis, has been explored by philosophers since time immemorial. Adding computers to the mix doesn't really change the philosophical question. It doesn't really even add a new dimension except perhaps for our perception of who or what can be trusted, and the question of what motivates the machine's responses. Humans' reactions are shaped by their experiences (what one might call "biases") and we see this unavoidably repeated with large language models. For example we have heard about racist outcomes from software that have been trained on available data and inherit its prejudices. We all have preconceptions when approaching different mathematical statements, in particular, in what we are ready to believe without further justification and what would requires a more detailed justification to allay any suspicion.

Pure mathematicians are trained to believe that there is a way to avoid bias and misunderstanding: We are taught early on that mathemematics starts from a small set of axioms, which can be arbitrary so long as they are consistent (so as to not be contradictory). These axioms and clear rules of inference are used to build up more and more mathematical truths on a rock solid basis (since one can verify through the rules of inference how one arrived at the claimed theorem). One hopes that one can arrive from a well chosen set of axioms to all interesting mathematical truths. However, thanks to Godel we know this is impossible (since no such axiomatic system can be complete). Even worse, Godel proved that one can't prove consistency from within the axiomatic system (to be fully correct I need some appropriate qualifiers but no matter). Despite these issues we pure mathematicians continue to want to believe that this is how we are proceeding in our research.

We have created a structure that imitates this belief. We publish our papers in journals that go through a review process (though few of us have faith that this infallibly picks up on errors). These papers are stored in libraries that are broadly accessible. This allows us to build on what we already know, or believe we know, and so, theoretically, for others to

© Richard Poissant

justify each step of a proof going back to the axioms. Sounds great but there are also all sorts of places in this process where one can imagine things going wrong. So what we have in the literature is a vast array of theorems that we believe, though with some reservation. For most of us, our beliefs develop confidence as we see how different claimed theorems fit together and create a rich mutually supporting tapestry. However one can't help but feel that some parts of the literature might be a House of Cards where if one key result is exposed to have perhaps even a minor problem, the rest of the structure could give way. The tapestry may then turn out to have a hard to fix flaw. (This happened in some of the best known work of Voevodsky, for example).

So what can we do to have more confidence inproof verifications? One idea is to automate the process. To have a computer program that is capable of interpreting the claims of authors and verifying that they fit the established literature as claimed is the goal of much of the proof verification software like Lean and Coq. As yet one has to translate mathematics into an obscure language that can be interpreted by the software, but this painful work is presumably temporary and programmers will work out how to translate from usual mathspeak to softwaremathspeak seamlessly).

Actually, Lean's language has not proven to be a formidable barrier, and many mathematicians are starting to embrace it. And this has led to some notable successes. Not only verification of some very difficult proofs (for example proofs of important, hot-off-the-press theorems by Clausen and Scholze, and by Gowers, Green, Manners and Tao), but also the process of explaining the proof in a way that is acceptable to Lean has helped researchers to reformulate parts of their arguments and in so doing sometimes to make significant improvements in their proofs. Lean's scope within mathematics and its accessibility in terms of language is rapidly improving and it seems plausible that some version of Lean or related software will become an integral part of every research mathematician's toolkit within the foreseeable future.

However should one completely believe what Lean has certified as true? Without any reservations? Has this process truly transcended any reasons to be sceptical about the certification of a proof? Could any of our existing mistakes or prejudices have entered into the library of Lean? For sure there are minor issues that can be eventually navigated (for example, definitions of a given object may be slightly different in slightly different subfields) but could there be more endemic

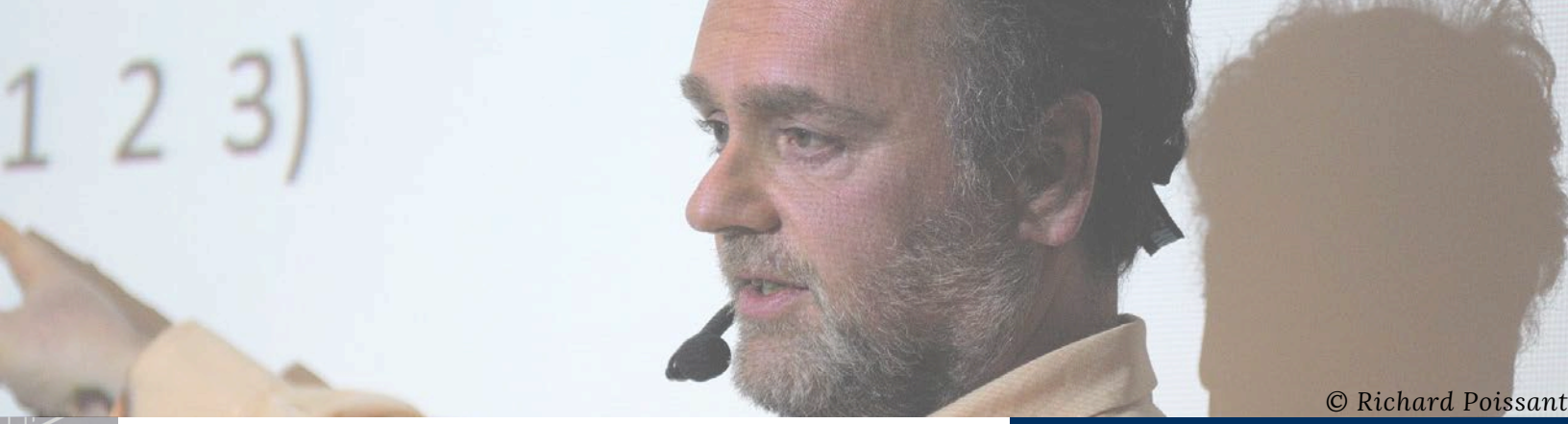
© Richard Poissant

problems? It is clear that some issues that have plagued the human liter-ature will be mostly resolved by Lean (for example, inconsistent definitions that are intuitively plausible) but can one be certain that all tricky issues can be dealt with just because of a different presentation of proof, a presentation which has certain new strengths?

Here is one reason to be skeptical: We have all had the experience of computers giving us wrong information; simple programming errors, subtle difficulties in the program decision tree (for example, there not being an option that corresponds to your situation) and other situations mean that in our personal lives we're quite aware that it's difficult to program in a way that truly takes into account all situations. Computer programs by airlines, banks or even universities have billions of dollars spent on their development and yet they are far from perfect. Why should one believe that programs constructed in university labs by a relativelysmall group of volunteers (albeit highly motivated and talented volunteers) are going to transcend the difficulties that one sees all too plainly in so much computing that we're familiar with?

Proof verification software is surely just the start. Proof generation is being developed in new and interesting ways. Traditionally proof generation programmes have taken the axiomatic viewpoint to build proofs up from known statements. Tim Gowers, who is leading a proof generation project, takes a different view. Proof generators should aim to better imitate human processes in developing proofs.Gowers makes the point that humans seem to be remarkably good at identifying interesting and provable statements and yet we don't really know how we do that. How do we know so well what are interesting truths? Gowers tries to give Shannon-like structure to these musings by asking to investigate the set of interesting provable statements as a tiny subset of the provable statements.

Gower's perspective has become seductive to people studying Lanrge Language Models (LLMs): Can these models, which develop understanding from published literature, better guess at the right paths to take than traditional proof generators? Or would we be best off with a combination of the two, the LLMs to make wild guesses and then the traditional software to verify and make minor modifications that might allow real progress? No one knows right now how to achieve the goal of having an automated proof generator but it is food for thought because there's no doubt that if such software is created it will



© Richard Poissant

greatly change our profession and how one proceeds in pure mathematical research.

Akshay Venkatesh proposed a thought experiment, software he called Aleph-Zero, which would have all of these abilities. What would that mean to our profession? Many mathematicians have recently been asking themselves different questions about what the most recent computer developments might mean for mathematical research. When the Fields Institute held its Fields medal symposium in honour of Venkatesh's work he proposed to instead have a wide-ranging discussion of a mathematical future changed by machines. The invitees included mathematicians, computer scientists, AI gurus, philosophers, and notably a social anthropologist. The idea was to compare perspectives and understandings. What became clear to us mathematicians is that people in other academic areas had perhaps invested more in asking themselves appropriate questions about their future. This stimulated me to propose a special issue of the Bulletin of the American Mathematical Society in which these issues would be discussed (in short essays) for the benefit of the broad mathematical community.

We asked a diverse set of editors to help us decide who to invite: You will see the output in the April and June 2024 issues of the Bulletin.

But, pure mathematicians, consider this: Most of what we do is develop proofs – our goal might be a conjectured theorem, but our day-to-day work is to develop approaches to proving the conjecture and then to try to make one of those approaches work (to our satisfaction).Our skill is largely built on our experience of what approaches can work in what situation and how to make them work. So what happens when that is the computer's job? When we first ask a computer to work out the details, or to decide whether an approach works, we will have had enough experience ourselves to lead the process. But gradually mathematicians will stop developing these skills – why would you train people to think so hard when it is faster and easier to let Aleph-Zero do the drudgery for them? But then, if one is not capable of directing the nuts-and-bolts of the research process, what will the mathematician be doing? Of course we are weird academics, obsessing on proofs as we do. We will probably become more like colleagues in other disciplines who focus more on the big picture and less on the details, but will we then lose what makes us fundamentally different? What will we be doing when the robots take over?

L'IRL - CRM :

COOPÉRATION FRANCE-QUÉBEC

RÉUNION D'EXPLORATION ET D'ÉVALUATION : L'IRL-CRM ET LA COOPÉRATION FRANCE-QUÉBEC EN SCIENCES MATHÉMATIQUES

27-28 FEVRIER 2024

A l'occasion du projet de renouvellement de la Convention liant le CNRS et l'Université de Montréal, qui dure depuis 2012, l'IRL CRM-CNRS et le CRM ont organisé deux journées autour des liens entre les chercheurs en mathématiques travaillant en France et ceux travaillant au Québec, pour célébrer les échanges entre eux.

La première journée était une journée plus institutionnelle: elle a débuté par une présentation par leurs directeurs respectifs du Centre de Recherches Mathématiques et de l'international research laboratory, qui s'appelait unité mixte internationale jusqu'en 2021, puis tous les chercheurs de France affectés à l'IRL ont présenté de manière synthétique leurs travaux de recherche, de la didactique à la théorie géométrique des groupes, de l'application des probabilités à la théorie des nombres ou à l'analyse de signaux biologiques à la géométrie symplectique par exemple, montrant la diversité des interactions possibles du CNRS L'après midi, les représentants de toutes les institutions partenaires du CRM (vice-recteurs des universités, la représentante du FRQNR, le représentant du CNRSG et les représentants du CNRS) ont débattu au cours d'une table ronde sur la nécessité de maintenir des mathématiques dans un monde où l'intelligence artificielle devrait pouvoir tout résoudre, Clairement, beaucoup d'arguments permettant de conserver un rôle important aux mathématiques, y compris les mathématiques amont, ont été mis en avant par tous, confirmant la foi dans les mathématiques. La fin d'après-midi a été consacrée aux lauréats et bénéficiaires de différents programmes permettant la mobilité Québec-France (fonds 'miroir' qui a été utilisé, depuis son renouvellement en 2022, par des étudiants comme par des chercheurs confirmés, pour faire des séjours ou participer à des congrès en France). Le mercredi 28 matin, d'anciens membres du laboratoire CNRS se sont aussi prêtés au jeu de l'exposé scientifique de 10 mn, pour la plupart à distance, et d'autres collègues québecois ont souligné l'utilisation de fonds donnés par la France ('postes rouges', projets de l'Agence Nationale de la Recherche), montrant la diversité des leviers de soutien des interactions.

Olivier Lafitte
(Directeur IRL-CRM)

VINCENT MASCIOTRA RETIRES

NEWS OF OUR TEAM

Vincent Masciotra took his retirement at the end of January 2024, after more than 25 years at the CRM. Past and present members of the CRM community came together to mark this occasion at a cocktail in his honor. Jacques Hurtubise, who was Deputy Director at the time Vincent was hired, recalled that "...this happened because the new Head of Administration at the time... told us that she had the ideal person to help us. After an interview, Vincent was hired, and soon our accounts were in fine shape.

After a few years, the Head of Administration position became open, and Vincent took that over too. The rest is history- Vincent politely pointing out omissions, things that the by then new Director (me) might have forgotten, and ensuring that the CRM ran smoothly for many years."

From left to right

- **Jacques Hurtubise** (McGill)
- **Christian Léger** (UdeM)
- **Tony Humphries** (McGill)
- **Vincent Masciotra**
- **Christiane Rousseau** (UdeM)
- **Octav Cornea** (UdeM)

Le BULLETIN

CENTRE DE RECHERCHES MATHÉMATIQUES

ISSN 1492-7659

Printemps- 2024

Volume 29 - N°1

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

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.

Galia Dafni
Directrice d'édition

Edouard Pontoizeau
Conception graphique

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

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

Crédit photos : © Richard Poissant
Équipe du CRM