Canadian Mathematical Society
Société mathématique du Canada

2023 CMS Winter Meeting

PROGRAMME

Réunion d'hiver de la SMC 2023

DECEMBER 1-4, 2023
DU 1ER AU 4 DÉCEMBRE 2023

Canadian Mathematical Society
Société mathématique du Canada

Thank you | Merci

to our hosts
à nos hôtes

Concordia

McGill
Department of Mathematics & Statistics
Département de mathématiques et de statistique

to our sponsors
à nos commanditaires

UQÀM | Département de mathématiques

McGill
Faculty of Science
Faculté des sciences

Mitacs

CRM
CENTRE DE RECHERCHES MATHÉMATIQUES

ISM
Institut des sciences mathématiques

TOURISME / MONTRÉAL

AARMS
Atlantic Association for Research in the Mathematical Sciences

FIELDS

Pacific Institute for the Mathematical Sciences

Table of Contents
Table des matières

CMS Winter Meeting 2023 | Réunion d'hiver de la SMC 2023
Hilton DoubleTree
Montreal

Friday | Vendredi December 1 décembre	Saturday | Samedi December 2 décembre	Sunday | Dimanche December 3 décembre	Monday | Lundi December 4 décembre
8:00 - 19:30 - Registration | Inscription Grand Salon Opera	7:30 - 18:00 - Registration | Inscription 8:30 - 16:30 - Poster Session Affiches 10:00 - 16:30 - Exhibits | Expositions Grand Salon Opera	7:30 - 18:00 - Registration | Inscription 8:30 - 16:30 - Poster Session Affiches 10:00 - 16:30 - Exhibits | Expositions Grand Salon Opera	7:30 - 18:00 - Registration | Inscription Grand Salon Opera
9:00 – 12:00 CMS Mini-Courses | Mini-cours de la SMC	8:00 – 10:30 Scientific Sessions Sessions Scientifiques	8:00 – 10:30 Scientific Sessions Sessions Scientifiques	8:00 – 10:30 Scientific Sessions Sessions Scientifiques
	10:30 – 11:00 Break | Pause Grand Salon Opera Foyer	10:30 – 11:00 Break | Pause Grand Salon Opera Foyer	10:30 – 11:00 Break | Pause Grand Salon Opera Foyer
12:30 – 16:30 CMS Board of Directors Meeting | Réunion du Conseil d'administration SMC	11:00 – 12:00 *Déborah Oliveros* Plenary Lecture Conférence plénière	11:00 – 12:00 *Jean-Marie De Koninck* Education Lecture Conférence sur l'éducation	11:00 – 12:00 *Vincent Bouchard* Plenary Lecture Conférence plénière
13:00 - 16:00 CMS Mini-Courses | Mini-cours de la SMC	12:00 – 13:30 Break | Pause	12:00 – 13:30 Break | Pause 12:15 - 13:15	12:00 – 13:30 Break | Pause 12:15 - 13:30
	13:30 – 14:30 *Edward Doolittle* Adrien Pouliot Prize Lecture | Conférence de Prix Adrien Pouliot	13:30 – 14:30 *Robert Haslhofer* Coxeter-James Prize Lecture | Conférence de Prix Coxeter-James	13:30 – 14:30 *Toni Annala* Doctoral Prize Lecture| Conférence de Prix de doctorat
	14:30 – 15:00 Break | Pause Grand Salon Opera Foyer	14:30 – 15:00 Break | Pause Grand Salon Opera Foyer	14:30 – 15:00 Break | Pause Grand Salon Opera Foyer
16:45 – 18:00 Opening Remarks and Mitacs Public Lecture *Yoshua Bengio* Conférence publique Mitacs Grand Salon Opera	15:00 – 18:00 Scientific Sessions Sessions Scientifiques	15:00 – 18:00 Scientific Sessions Sessions Scientifiques	15:00 – 18:00 Scientific Sessions Sessions Scientifiques
18:00 – 19:30 Welcome Reception | Réception	19:00 – 21:00 Student Social | Soirée étudiante	19:00 – 22:30 Reception and Awards Banquet Réception et Banquet de prix Inspiration Ballroom (Hilton DoubleTree)	

SATURDAY | SAMEDI

#	ROOM	SALLE	SATURDAY | SAMEDI AM	SATURDAY | SAMEDI PM
1	SOPRANO A	Mathematics of Machine Learning | Mathématiques de l'apprentissage automatique		
2	SOPRANO B	Current Trends in Matrices, Graphs, and Computing | Tendances actuelles dans les matrices, les graphes et l'informatique		
3	SOPRANO C	Combinatorial Design Theory | Théorie de la conception combinatoire		
4	SYMPHONIE 1		Descriptive Set Theory | Théorie descriptive des ensembles	
5	OVATION	Harmonic Analysis and PDE | Analyse harmonique & EDP		
6	GRAND SALON OPERA A	Education Sessions | Sessions d'éducation		
7	GRAND SALON OPERA B	Number Theory by Early Career Researchers | Théorie des nombres par des chercheurs en début de carrière		
8	GRAND SALON OPERA C	Geometric Functional Analysis: Analytic, Discrete, and Probabilistic Aspects | Analyse fonctionnelle géométrique : Aspects analytiques, discrets et probabilistes		
9	CREATION	Advancements in Matrix Theory with Applications | Les avancements dans la théorie des matrices avec leurs applications		
10	IMAGINATION	The Many Facets of Random Matrix Theory | Les multiples facettes de la théorie des matrices aléatoires		
11	MAESTRO	Commutative Algebra | Algèbre commutative		
12	SYMPHONIE 2A	Geometric Partial Differential Equations | Équations géométriques différentielles partielles		
13	INSPIRATION	Cluster Algebras in Representation Theory | Les groupes d'algèbres dans la théorie des représentations		
14	SYMPHONIE 2B	Algebraic, Arithmetic and Kahler Geometry: Recent developments | Géométrie algébrique, arithmétique et de Kahler : développements récents		
15	SYMPHONIE 3A	Homotopy Theory | Théorie de l'homotopie		
16	SYMPHONIE 3B	Recent Progress in Statistical Mechanics | Progrès récents dans les mécanique statistiques		
17	SYMPHONIE 4A	Geometric Analysis | Analyse géométrique		
18	SYMPHONIE 4B	A Celebration in Honor of Jean-Marie De Koninck's 75th Birthday: Elementary and Analytic Number Theory | Théorie élémentaire et analytique des nombres: une célébration à l'honneur du 75ème anniversaire de Jean-Marie De Koninck		
19	SYMPHONIE 7	Geometry in Calculus of Variations and PDEs | La géométrie dans le calcul des variations et des EDP		
UQAM SESSIONS | SESSIONS DE L'UQAM				
20	PK-1320	Stochastic Control Theory and Applications | Théorie du contrôle stochastique et ses applications		
21	PK-1620	Computational and Geometric Spectral Theory | Théorie spectracle computationnelle et géométrique		
22	PK-2205	Automorphic representations and p-adic aspects of the Langlands program | Représentations automorphes et aspects p-adiques du programme de Langlands		
23	PK-2605	Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations | Modèles, méthodes et solutions : nouveaux développements dans les équations aux dérivées partielles non linéaires et les équations différentielles stochastiques		
24	PK-6605	Mathematics in the Public Sector | Les mathématiques dans le secteur public		
25	PK-7210	Wave Phenomena and Partial Differential Equations | Les phénomènes ondulatoires et équations aux dérivées partielles		
26	SH-3220	Functional Analytic Tools for Financial Decision Making | Outil d'analyse fonctionnelle pour la prise de décision financière		

SUNDAY | DIMANCHE

#	ROOM	SALLE	SUNDAY | DIMANCHE AM	SUNDAY | DIMANCHE PM
1	SOPRANO A	Mathematics of Machine Learning | Mathématiques de l'apprentissage automatique	
2	SOPRANO B	Current Trends in Matrices, Graphs, and Computing | Tendances actuelles dans les matrices, les graphes et l'informatique	
3	SOPRANO C	Combinatorial Design Theory | Théorie de la conception combinatoire	
4	SYMPHONIE 1	Descriptive Set Theory | Théorie descriptive des ensembles	
5	OVATION	Harmonic Analysis and PDE | Analyse harmonique & EDP	
6	GRAND SALON OPERA A	Education Sessions | Sessions d'éducation	
7	GRAND SALON OPERA B	Number Theory by Early Career Researchers | Théorie des nombres par des chercheurs en début de carrière	
8	GRAND SALON OPERA C	Geometric Functional Analysis: Analytic, Discrete, and Probabilistic Aspects | Analyse fonctionnelle géométrique : Aspects analytiques, discrets et probabilistes	
9	CREATION	Advancements in Matrix Theory with Applications | Les avancements dans la théorie des matrices avec leurs applications	
10	IMAGINATION	The Many Facets of Random Matrix Theory | Les multiples facettes de la théorie des matrices aléatoires	
11	MAESTRO	Commutative Algebra | Algèbre commutative	
12	SYMPHONIE 2A	Functional Analytic Tools for Financial Decision Making | Outils d'analyse fonctionnelle pour la prise de décision financière	
13	INSPIRATION	Cluster Algebras in Representation Theory | Les groupes d'algèbres dans la théorie des représentations	
14	SYMPHONIE 2B	Algebraic, Arithmetic and Kahler Geometry: Recent developments | Géométrie algébrique, arithmétique et de Kahler : développements récents	Student Research Session | Session de recherche des étudiants
15	SYMPHONIE 3A	Homotopy Theory | Théorie de l'homotopie	
16	SYMPHONIE 3B	Algebraic and Enumerative Combinatorics | Combinatoire algébrique et énumérative	
17	SYMPHONIE 4A	Geometric Analysis | Analyse géométrique	
18	SYMPHONIE 4B	Algebraic Graph Theory for Walking on Graphs | Théorie algébrique des graphes pour la marche sur les graphes	
19	SYMPHONIE 7	Geometry in Calculus of Variations and PDEs | La géométrie dans le calcul des variations et des EDP	
UQAM SESSIONS | SESSIONS DE L'UQAM			
20	PK-1320	Stochastic Control Theory and Applications | Théorie du contrôle stochastique et ses applications	
21	PK-1620	Computational and Geometric Spectral Theory | Théorie spectracle computationnelle et géométrique	
22	PK-2205	Automorphic representations and p-adic aspects of the Langlands program | Représentations automorphes et aspects p-adiques du programme de Langlands	
23	PK-2605	Models, Methods and Solutions : New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations | Modèles, méthodes et solution : nouveaux développements dans les équations aux dérivées partielles non linéaires et les équations différentielles stochastiques	
24	PK-3205	Mathematical, Statistical, and AI Modelling of Mpox and related diseases | Modélisation mathématique, statistique et IA du Mpox et des maladies associées	

MONDAY | LUNDI

#	ROOM	SALLE	MONDAY | LUNDI AM	MONDAY | LUNDI PM
1	GRAND SALON OPERA AB	Geometric Functional Analysis: Analytic, Discrete, and Probabilistic Aspects | Analyse fonctionnelle géométrique : Aspects analytiques, discrets et probabilistes		
2	SYMPHONIE 2B	Student Research Session | Session de recherche des étudiants		
3	SYMPHONIE 3A	Homotopy Theory | Théorie de l'homotopie		
4	SYMPHONIE 3B	Algebraic and Enumerative Combinatorics | Combinatoire algébrique et énumérative		
5	SYMPHONIE 4B	Algebraic Graph Theory for Walking on Graphs | Théorie algébrique des graphes pour la marche sur les graphes		

PRESIDENT'S WELCOME LETTER

On behalf of the Canadian Mathematical Society, it is my pleasure to welcome you to Montréal and the 2023 CMS Winter Meeting. Co-hosted by Concordia University and McGill University, this conference promises to provide many opportunities to gather together and to engage in mathematical discussion. The scientific organizing committee, led by directors François Bergeron (UQAM), Simone Brugiapaglia (Concordia University), and Alina Stancu (Concordia University), have built a program of 30 sessions, four mini-courses and a workshop, on a diverse collection of topics spanning pure mathematics, applied mathematics, mathematics education, as well as probability and statistics.

The conference programme begins with a public lecture on Friday December 1st by Yoshua Bengio (UDM and Founder of Mila - Quebec AI Institute). Also featured are three plenary lectures by Jean-Marie De Koninck (Université Laval), Vincent Bouchard (University of Alberta), and Déborah Oliveros (UNAM). Other special events during the conference include a student poster session on the weekend, an LGBTQ2S+ Lunchtime Discussion on the 2nd, and several prize lectures.

At the banquet scheduled for Sunday evening, we will celebrate and recognise Edward Doolittle (First Nations University of Canada) as a winner of the Adrien Pouliot Prize, Robert Haslhofer (University of Toronto) as a winner of the Coxeter-James Prize, Toni Annala (Institute for Advanced Study, Princeton) as a winner of the Blair Spearman Doctoral Prize, Stefanos Aretakis (University of Toronto) as a winner of the Cathleen Synge Morawetz Prize, Dorette Pronk (Dalhousie University) as a winner of the Graham Wright Award, and Hector Pasten (Pontificia Universidad Catolica de Chile) as a winner of the G. de B. Robinson Award. Winners from the student poster session will also be honoured during the banquet.

A conference as large and diverse as this one is only possible thanks to a tremendous effort from people such as the scientific directors and their committee, the many session organizers and speakers, volunteers, the co-host universities, and CMS staff, to all of whom I extend our collective thanks. On behalf of the Society, I also wish to express our gratitude to the sponsors of the meeting: the Département de mathématiques at UQAM, the Faculty of Science at McGill University, Mitacs, CRM, ISM, Tourisme Montréal, AARMS, Fields, and PIMS.

To the conference participants, I hope that you have a positive and productive meeting, and that you enjoy coming together to discuss mathematics. If you are not currently a CMS member, the CMS staff at the registration desk will be pleased to tell you about the Society's many activities above and beyond hosting conferences.

Welcome

David

LETTRE DE BIENVENUE DU PRÉSIDENT

Au nom de la Société mathématique du Canada, j'ai le plaisir de vous souhaiter la bienvenue à Montréal et à la Réunion d'hiver 2023 de la SMC. Accueillie conjointement par l'Université Concordia et l'Université McGill, cette conférence promet d'offrir de nombreuses occasions de se rassembler et de participer à des discussions mathématiques. Le comité organisateur scientifique, dirigé par les directeurs François Bergeron (UQAM), Simone Brugiapaglia (Université Concordia) et Alina Stancu (Université Concordia), a élaboré un programme de 30 sessions, quatre mini-cours et un atelier, sur un ensemble diversifié de sujets couvrant les mathématiques pures, les mathématiques appliquées, la didactique des mathématiques, ainsi que les probabilités et les statistiques.

Le programme de la conférence commence par une conférence publique le vendredi 1er décembre par Yoshua Bengio (UDM et fondateur de Mila - Institut québécois de l'IA). Trois conférences plénières seront également proposées par Jean-Marie De Koninck (Université Laval), Vincent Bouchard (Université d'Alberta) et Déborah Oliveros (UNAM). D'autres événements spéciaux se dérouleront pendant la conférence, notamment une session d'affiches pour les étudiants pendant le week-end, un dîner-discussion LGBTQ2S+ le 2, et plusieurs conférences de prix.

Lors du banquet prévu le dimanche soir, nous célébrerons et reconnaîtrons Edward Doolittle (*First Nations University of Canada*) comme lauréat du prix Adrien Pouliot, Robert Haslhofer (Université de Toronto) comme lauréat du prix Coxeter-James, Toni Annala (*Institute for Advanced Study, Princeton*), lauréat du prix doctoral Blair Spearman, Stefanos Aretakis (Université de Toronto), lauréat du prix Cathleen Synge Morawetz, Dorette Pronk (Université Dalhousie), lauréate du prix Graham Wright, et Hector Pasten (*Pontificia Universidad Catolica de Chile*), lauréat du prix G. de B. Robinson. Les lauréats de la session d'affiches des étudiants seront également récompensés lors du banquet.

Une conférence aussi vaste et diversifiée que celle-ci n'est possible que grâce aux efforts considérables de personnes telles que les directeurs scientifiques et leur comité, les nombreux organisateurs de sessions et conférenciers, les bénévoles, les universités co-hôtes et le personnel de la SMC, à qui je transmets nos remerciements collectifs. Au nom de la Société, je souhaite également exprimer notre gratitude aux commanditaires de la réunion : le Département de mathématiques de l'UQAM, la Faculté des sciences de l'Université McGill, Mitacs, CRM, ISM, Tourisme Montréal, AARMS, Fields et PIMS.

Aux participants à la conférence, j'espère que votre réunion sera positive et productive, et que vous prendrez plaisir à vous réunir pour discuter des mathématiques. Si vous n'êtes pas encore membre de la SMC, le personnel de la SMC présent au bureau d'inscription se fera un plaisir de vous renseigner sur les nombreuses activités de la Société, au-delà de l'organisation de conférences.

Bienvenue

David Cox

A WORD FROM THE SCIENTIFIC DIRECTORS

UN MOT DES DIRECTEURS SCIENTIFIQUES

Welcome to the 2023 CMS Winter Meeting! In keeping with tradition, this meeting brings together members of our diverse community that includes students, researchers, teachers and professors from academia and industry. The broad spectrum of activities offered reflects the richness and high level of mathematical research in Canada, innovative approaches to various teaching challenges, and its original applications to real-world problems. The opening public lecture will stimulate our curiosity with surprising interactions between mathematics and artificial intelligence. With each of the three plenary speakers, we will explore the excitement of scientific discovery, the beauty of mathematics and physics, and the construction of fascinating geometric objects. In addition to this already enticing line-up, there will be plenary lectures by CMS annual award winners, 30 high-calibre scientific sessions, mini-courses, along with student talks, poster sessions, and much more.

François Bergeron

Our warmest thanks go to the members of the scientific organizing committee, organizers of scientific and education sessions and mini-courses, student volunteers, and, especially, to the CMS staff.

Simone Brugiapaglia

Bienvenue à la Réunion d'hiver 2023 de la Société mathématique du Canada ! Comme d'habitude, cette rencontre permet de réunir les divers membres de notre communauté : étudiants, chercheurs et professeurs ; autant en provenance des milieux de la recherche et de l'enseignement, que de l'industrie. Le grand spectre des activités au menu reflète la richesse et le haut niveau des recherches en mathématiques au Canada, les approches innovatrices à divers défis de son enseignement, ainsi que ses applications originales à de nombreux domaines. La conférence d'ouverture risque de nous provoquer par la diversité d'interactions insoupçonnées entre Mathématiques et Intelligence artificielle. Nous aurons aussi droit à des conférences plénières explorant l'euphorie de la découverte, la beauté des mathématiques de la physique, et la fascination qu'exercent les objets géométriques. À ce menu déjà enlevant, s'ajoutent les conférences plénières des récipiendaires des prix annuels de la société, 30 sessions scientifiques de haut calibre, des mini-cours, sans oublier la séance d'affiche des étudiants.

Alina Stancu

Nous remercions très chaudement les membres du Comité d'organisations scientifique, les organisateurs de sessions scientifiques, d'éducation, et de mini-cours, les étudiants bénévoles, et plus particulièrement le personnel de la SMC.

A WORD OF WELCOME FROM TOURISME MONTRÉAL

On behalf of Tourisme Montréal and its tourism industry partners, I am very pleased to welcome you to Montréal.

We are excited to be hosting the 2023 CMS Winter Meeting and proud to be sharing all there is to see and do in our city. We hope that this December's convention provides you with many meaningful networking and educational opportunities, as well as stimulating discussions with your peers. You should feel right at home in this City of Knowledge, proud home to 11 higher learning institutions, including four universities.

Montréal is an exciting destination year-round, but as we head into the holiday season, a magical atmosphere fills the air, with twinkling lights and breathtaking illuminations. We invite you to make the most out of the city's shops, nightlife, cultural experiences and world-renowned food scene—you'll find surprising culinary discoveries around every corner.

We wish you an excellent meeting and an enjoyable stay!

Yves Lalumière
President and Chief Executive Officer

UN MOT DE BIENVENUE DE TOURISME MONTRÉAL

Au nom de Tourisme Montréal et de ses partenaires de l'industrie touristique, je suis ravi de vous accueillir à Montréal.

Nous sommes enchantés de recevoir la Réunion d'hiver 2023 de la SMC et fiers de partager avec vous tout ce que la métropole a à offrir. Puisse cette rencontre de décembre vous fournir de nombreuses occasions de réseautage, des perspectives éducatives et des discussions stimulantes avec vos pairs. Ville de savoir avec ses 11 établissements d'enseignement supérieurs, dont quatre universités, Montréal est le lieu tout indiqué pour cette réunion.

Destination de choix en tout temps, Montréal est particulièrement séduisante à l'approche des fêtes de fin d'année, avec ses décorations scintillantes et ses illuminations à couper le souffle. Nous vous invitons à profiter pleinement de ses boutiques, de sa vie nocturne, de ses expériences culturelles et de sa gastronomie renommée. Vous ferez de surprenantes découvertes culinaires dans chacun de ses quartiers.

Nous vous souhaitons une excellente réunion et un agréable séjour à Montréal.

Yves Lalumière
Président-directeur général

CLASS OF FELLOWS 2023
COHORTE 2023 DES FELLOWS

Congratulations **to the CMS Class of Fellows 2023**

Elena Braverman

Barbara Csima

Niky Kamran

Henry Kim

Hershy Kisilevsky

Nilima Nigam

Dorette Pronk

Félicitations **à la Cohorte 2023 des Fellows de la SMC**

COXETER-JAMES PRIZE

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Robert Haslhofer (University of Toronto) has been named the recipient of the 2023 Coxeter-James Prize for his outstanding contributions to Riemannian geometry and geometric analysis, especially mean curvature and Ricci flows.

Dr. Haslhofer was awarded his Ph.D. in Mathematics from ETH Zurich in 2012. Since then Dr. Haslhofer has continued on an impressive trajectory. After three years as a Courant Instructor at New York University's Courant Institute of Mathematical Sciences, he joined the Department of Mathematics at the University of Toronto in 2015.

Lauded by his colleagues as "one of the most distinguished and most promising mathematicians worldwide in Riemannian geometry and geometric analysis," Dr. Haslhofer's scientific work with various collaborators include novel characterizations of Ricci flows, study of mean curvature flows through neck singularities, and impressive contributions to stochastic analysis on path spaces.

Haslhofer's work with Aaron Naber on Ricci flow solves a deep and long-standing question in this active area: An ingenious notion of weak solution of Ricci flow is introduced through stochastic analysis on the Ricci-flow spacetime. This allows for the definition of Ricci-flow on singular spaces, and in particular yields the first satisfactory notion of Ricci flow through singularities. This work uses ideas from stochastic analysis in a profound and original way. It is a major result, likely to facilitate many important further developments.

With Dan Ketover, Haslhofer used min-max theory to establish that every generic metric on the 3-sphere admits at least two embedded minimal two-spheres, thus disproving a conjecture of Shing-Tung Yau concerning ellipsoids.

However, his most spectacular achievement to date is the resolution of the mean-convex neighbourhood conjecture for singularities of mean-curvature flow, a twenty-year old conjecture of his PhD advisor Tom Ilmanen. Together with his collaborator Kyeongsu Choi and his former PhD student Or Hershkovits, Haslhofer resolved this conjecture first for surfaces (Acta Mathematica 2022), and then with the addition of Brian White in higher dimensions (Inventiones 2022). Instead of assuming that the initial condition possesses some form of symmetry or convexity, Ilmanen's conjecture states that it develops mean-convexity in a spacetime neighbourhood of any asymptotically cylindrical singularity (after which existing theory can then be applied).

The CMS is delighted to present Dr. Haslhofer with the 2023 Coxeter-James Prize for his incredibly important addition to Riemannian geometry and geometric analysis, especially mean curvature and Ricci flows.

PRIX COXETER-JAMES

La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Dr Robert Haslhofer (Université de Toronto) a été nommé récipiendaire du prix Coxeter-James 2023 pour ses contributions exceptionnelles à la géométrie riemannienne et à l'analyse géométrique, en particulier la courbure moyenne et les flots de Ricci.

Dr Haslhofer a obtenu son doctorat en mathématiques à l'ETH Zurich en 2012. Depuis, Dr Haslhofer a poursuivi une trajectoire impressionnante. Après trois ans en tant que professeur au *Courant Institute of Mathematical Sciences* de l'Université de New York, il a rejoint le département de mathématiques de l'Université de Toronto en 2015.

Qualifié par ses collègues de "l'un des mathématiciens les plus distingués et les plus plus prometteurs du monde en géométrie riemannienne et en analyse géométrique", le travail scientifique du Dr Haslhofer avec divers collaborateurs comprend de nouvelles caractérisations des flots de Ricci, l'étude des flux de courbure moyenne à travers les singularités du cou, et des contributions impressionnates à l'analyse stochastique sur les espaces de chemin.

Le travail de Haslhofer avec Aaron Naber sur les flots de Ricci résout une question profonde et ancienne dans ce domaine actif : une notion ingénieuse de solution faible du flot de Ricci est introduite par le biais de l'analyse stochastique sur l'espace-temps du flot de Ricci. Cela permet de définir le flot de Ricci sur les espaces singuliers et, en particulier, d'obtenir la première notion satisfaisante de flot de Ricci à travers les singularités. Ce travail utilise les idées de l'analyse stochastique d'une manière profonde et originale. Il s'agit d'un résultat majeur, susceptible de faciliter de nombreux développements ultérieurs importants.

Avec Dan Ketover, Haslhofer a utilisé la théorie min-max pour établir que toute métrique générique sur la sphère 3 admet au moins deux sphères minimales intégrées, réfutant ainsi une conjecture de Shing-Tung Yau concernant les ellispsoïdes.

Toutefois, sa réalisation la plus spectaculaire à ce jour est la résolution de la conjecture du voisinage convexe moyen pour les singularités du flux à courbure moyenne, une conjecture vieille de 20 ans de son directeur de thèse Tom Ilmanen. Avec son collaborateur Kyeongsu Choi et son ancien doctorant Or Hershkovits, Haslhofer a résolu cette conjecture d'abord pour les surfaces (Acta Mathematica 2022), puis avec l'aide de Brian White dans les dimensions supérieures (Inventiones 2022). Au lieu de supposer que la condition initiale possède une certaine forme de symétrie ou de convexité, la conjecture d'Ilmanen affirme qu'elle développe une convexité moyenne dans un voisinage spatio-temporal de toute singularité asymptotiquement cylindrique (après quoi la théorie existante peut être appliquée).

La SMC est ravie de décerner au Dr Haslhofer le prix Coxeter-James 2023 pour son apport incroyablement important à la géométrie riemannienne et à l'analyse géométrique, en particulier à la courbure moyenne et aux flots de Ricci.

BLAIR SPEARMAN DOCTORAL PRIZE

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Toni Annala (Institute for Advanced Study, Princeton) has been named the 2023 CMS Blair Spearman Doctoral Prize recipient. Dr. Annala is an exceptional researcher working at the interface of algebraic geometry and algebraic topology, focusing on the development of cohomology theories using derived techniques. During his doctoral studies at the University of British Columbia (2017-2020, 2022), where he worked under the mentorship of Dr. Kalle Karu, Annala wrote more than 10 original research articles — of which more than half are single author. Across his thesis and these articles, almost all of which are now published or accepted in excellent journals such as Annales de l'Institut Fourier, Journal of the European Mathematical Society, and Advances in Mathematics, Annala has made significant contributions to an emerging theory of derived algebraic cobordism.

In his thesis and papers, Annala significantly extends a deep sequence of existing work on Chow theory, K-theory, and algebraic cobordism theory, including results of Voevodsky, Fulton-MacPherson, Levine-Morel, and Levine-Pandharipande. One of the key challenges motivating this sequence of investigations has been to define bivariant versions of Chow theory and K-theory on singular varieties that include both a homology and a cohomology, so that classes can be multiplied or intersected. Annala's contribution to these works is a sweeping one: he has produced a bivariant cobordism theory, the cohomology of which generalizes the cohomology of the bivariant K-theory of Fulton-MacPherson and providing a candidate for a Chow cohomology theory, which has been open for some time.

To achieve this, Annala has made careful and deep investigations into derived algebraic geometry. Through associated techniques, he has been able to remove some restrictions in the prior work of others, such as the need for a certain homotopy invariance required to produce geometric descriptions of Grothendieck groups of vector bundles on schemes. One referee remarks that Annala's thesis work is "more on the level of a German Habilitation presented by an experienced researcher than what one might expect from a doctoral student." He added that "the work presented here has already had a significant impact on this area of research and has received corresponding international attention."

We also recognize that Annala, in parallel to his work in algebraic geometry, has been active in other areas of mathematics and science, such as topological aspects of condensed matter physics and the development of quantum algorithms, leading to further publications. His ability to pursue these investigations in parallel and with great success speaks to Annala's remarkable independence as a graduate student. Taken all together, Annala's works are suggestive of a broad vision for geometry, algebra, topology, and computation in mathematics and science. We foresee further groundbreaking work from Dr. Annala in the years to come.

PRIX DE DOCTORAT BLAIR SPEARMAN

La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Dr Toni Annala (*Institute for Advanced Study*, *Princeton*) a été nommé lauréat du prix de doctorat Blair Spearman de la SMC pour 2023. Dr Annala est un chercheur expectionnel qui travaille à l'interface de la géométrie algébrique et de la topologie algébrique, en se concentrant sur le développement de théories de cohomologie à l'aide de techniques dérivées. Au cours de ses études doctorales à l'Université de la Colombie-Britannique (2017-2020, 2022), où il a travaillé sous le mentorat du Dr Kalle Karu, Annala a écrit plus de 10 articles de recherche originaux - dont plus de la moitié en tant qu'auteur unique. À travers sa thèse et ces articles, qui sont presque tous maintenant publiés ou acceptés dans d'excellentes revues telles que Annales de l'Institut Fourier, *Journal of the European Mathematical Society*, et *Advances in Mathematics*, Annala a apporté des contributions significatives à une théorie émergente du cobordisme algébrique dérivé.

Dans sa thèse et ses articles, Annala étend de manière significative une série de travaux existants sur le théorie de Chow, la K-théorie et la théorie du cobordisme algébrique, y compris les résultats de Voevodsky, Fulton-MacPherson, Levine-Morel et Levine-Pandharipande. L'un des principaux défis motivant cette série de recherches a été de définir des versions bivariantes de la théorie de Chow et de la K-théorie sur les variétés singulières qui incluent à la fois une homologie et une cohomologie, de sorte que les classes puissent être multipliées ou intersectées. La contribution d'Annala à ces travaux est considérable: il a produit une théorie bivariante du cobordisme, dont la cohomologie généralise la cohomologie de la K-théorie bivariante de Fulton-MacPherson et fournit un candidat pour une théorie de la cohomologie de Chow, qui est ouverte depuis un certain temps.

Pour y parvenir, Annala a mené des recherches approfondies et minutieuses sur la géométrie algébrique dérivée. Grâce aux techniques associées, il a pu supprimer certaines restrictions dans les travaux antérieurs d'autres chercheurs, comme la nécessité d'une certaine invariance de l'homotopie requise pour produire des descriptions géométriques des groupes de Grothendieck des faisceaux de vecteurs sur les schémas. Un arbitre remarque que le travail de thèse d'Annala est "plus du niveau d'une habilitation allemande présentée par un chercheur expérimenté que de ce que l'on pourrait attendre d'un étudiant en doctorat". Il a ajouté que "le travail présenté ici a déjà eu un impact significatif sur ce domaine de recherche et a reçu l'attention internationale correspondante".

Nous reconnaissons également qu'Annala, parallèlement à ses travaux en géométrie algébrique, a été actif dans d'autres domaines des mathématiques et des sciences, tels que les aspects topologiques de la physique de la matière condensée et le développement d'algorithmes quantiques, ce qui a donné lieu à d'autres publications. Sa capacité à poursuivre ces recherches en parallèle et avec succès témoigne de l'indépendance remarquable d'Annala en tant qu'étudiant diplômé. Dans l'ensemble, les travaux d'Annala suggèrent une vision large de la géométrie, de l'algèbre, de la topologie et de l'informatique en mathématiques et en sciences. Nous prévoyons d'autres travaux novateurs du Dr Annala dans les années à venir.

GRAHAM WRIGHT AWARD

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Dorette Pronk (Dalhousie University) has been named the recipient of the 2023 Graham Wright Award for Distinguished Service.

Dr. Pronk has made consistent and significant contributions to the Canadian mathematical community and to the Canadian Mathematical Society. She has served as the Chair of the Math Competitions Committee since 2016, as Chair of the IMO Committee from 2014 till 2015 and as Chair of the EGMO committee since 2018. Additionally, she has represented Canada many times as leader and deputy leader of Math Team Canada, at the International Math Olympiad, the European Girls Math Olympiad and the Pan American Girls Math Olympiad. In 2018, she was instrumental in securing Canada's first participation in the European Girls Math Olympiad. She has also served as member of the Women in Math Committee and was part of the team organizing the first Connecting Women in Math Across Canada workshop.

Dr. Pronk is a Professor of Mathematics at Dalhousie University whose research program is in category theory with applications to geometry, topology, and computational semantics. She serves on the boards of the Applied Category Theory conferences and the Foundational Methods in Computer Science workshops, and she serves on the editorial board of two category theory journals: Cahiers de Topologie et Géométrie Différentielle Catégoriques and Applied Categorical Structures. She has also served on the Executive Committee of AARMS (the Atlantic Association for Research in the Mathematical Sciences) and the Mathematics and Statistics Committee of Science Atlantic.

She is active in local outreach in Nova Scotia, as organizer of the Dalhousie Math Challenge Club and former faculty advisor of the Nova Scotia Math Circles. She was instrumental in securing the second round of funding by Eastlink for this program. In collaboration with Nova Scotia Math Circles, she has recently started the Indigenous Math Circle, a new after-school math program for Indigenous students in the Halifax Regional Centre for Education.

A common theme expressed by those who nominated Dr. Pronk is her care and dedication to personal mentorship, providing encouragement and advice along with compassion.

Her contributions have been invaluable to raising passion for and access to mathematics among young Canadians, especially for female and non-binary students.

Dr. Pronk earned her doctorate in mathematics in 1995 at Utrecht University in the Netherlands. Since joining the faculty at Dalhousie University in 2000, she has supervised numerous undergraduate and graduate students as well as post-doctoral fellows, in whom she instills the importance of outreach work in addition to their research.

PRIX GRAHAM WRIGHT

La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Dr Dorette Pronk (Université Dalhousie) a été nommée lauréate du prix Graham Wright 2023 pour services émérites.

Dr Pronk a apporté des contributions constantes et importantes à la communauté mathématique canadienne et à la SMC. Elle est présidente du comité des compétitions mathématiques depuis 2016 ainsi que présidente du comité EGMO depuis 2018, et elle a été présidente du comité IMO de 2014 à 2015. De plus, elle a représenté le Canada a de nombreuses reprises en tant que cheffe et cheffe adjointe de l'équipe de mathématiques du Canada, à l'Olympiade internationale de mathématiques, à l'Olympiade européenne de mathématiques pour filles, et à l'Olympiade panaméricaine de mathématiques pour filles. En 2018, elle a joué un rôle déterminant dans l'obtention de la première participation du Canada à l'Olympiade européenne de mathématiques pour filles. Elle a également été membre du Comité des femmes en mathématiques et a fait partie de l'équipe qui a organisé le premier atelier *Connecting Women in Math Across Canada* (Connecter les femmes en mathématiques à travers le Canada).

Dr Pronk est professeure de mathématiques à l'Université Dalhousie. Son programme de recherche porte sur la théorie des catégories et ses applications à la géométrie, à la topologie et à la sémantique informatique. Elle est membre du conseil d'administration des conférences *Applied Category Theory* et des ateliers *Foundational Methods in Computer Science*, ainsi que du comité de rédaction de deux revues consacrées à la théorie des catégories : Cahiers de Topologie et Géométrie Différentielle Catégoriques, et *Applied Categorical Structures*. Elle a également siégé au comité exécutif de l'AARMS et au comité *Mathematics & Statistics* de *Science Atlantic*.

Elle est active dans le domaine de la sensibilisation locale en Nouvelle-Écosse, en tant qu'organisatrice du *Dalhousie Math Challenge Club* et ancienne conseillère pédagogique des *Nova Scotia Math Circles*. Elle a joué un rôle déterminant dans l'obtention du deuxième cycle de financement d'*Eastlink* pour ce programme. En collaboration avec les *Nova Scotia Math Circles*, elle a récemment lancé l'*Indigenous Math Circle*, un nouveau programme de mathématiques après l'école destiné aux élèves autochtones du *Halifax Regional Centre for Education*.

Les personnes qui ont proposé la candidature de Dr Pronk ont toutes mentionné l'attention et le dévouement dont elle fait preuve en tant que mentore personnelle, en prodiguant des encouragements et des conseils et en faisant preuve de compassion.

Sa contribution a été inestimable pour susciter la passion et l'accès aux mathématiques chez les jeunes Canadiens, en particulier chez les étudiantes ainsi que les étudiants non binaires.

Dr Pronk a obtenu son doctorat en mathématiques en 1995 à l'Université d'Utrecht, aux Pays-Bas. Depuis qu'elle a rejoint la faculté de l'Université Dalhousie en 2000, elle a supervisé de nombreux étudiants de premier et deuxième cycles ainsi que des boursiers post-doctoraux, à qui elle a inculqué l'importance du travail de sensibilisation en plus de leurs recherches.

ADRIEN POULIOT AWARD

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Edward Doolittle is the recipient of the 2023 Adrien Pouliot Award in recognition of his outstanding contributions to mathematics education. He will be presented with his award at the 2023 CMS Winter Meeting.

Dr. Doolittle is Kanyen'kehake, a member of the Lower Mohawk band of Six Nations. He earned a PhD in pure mathematics from the University of Toronto in 1997 with his thesis on partial differential equations. Since 2001, he has been first a faculty member at First Nations University of Canada (formerly the Saskatchewan Indian Federated College). His duties there include teaching, research,

Dr. Doolittle is an internationally recognized leader on Indigenous mathematics and related concepts like Indigenizing mathematics, traditional mathematics, and ethnomathematics. For two decades he has worked tirelessly to introduce us to insights around the ways in which mathematics as a field of study intersects with Indigenous knowledge systems, and the educational possibilities afforded by those different views of mathematics. Dr. Doolittle has done this through such things as his leadership of working groups at the CMS Mathematics Education Forum in 2005, a plenary address at the 2006 Canadian Mathematics Education Study Group (CMESG) Annual meeting, leadership of a working group at the 2010 CMESG Annual meeting, by playing a key role in a series of BIRS workshops dedicated to First Nations Mathematics, through his research projects with educational researchers, his publications in educational journals and books, and his extensive community outreach.

A quiet but passionate voice for change, Dr. Doolittle's service at the national, provincial, and local levels also includes serving as member of Revisioning, Reclaiming, Reconciling School Mathematics, a group of academics, educators, and administrators developing Indigenous math curriculum and policy proposals for the next round of K-12 math curriculum revision in Saskatchewan, 2015-2018; as a member of the Academic Restructuring Committee at First Nations University, 2016-2018, and as Secretary/Treasurer of the Native Heritage Foundation of Canada, 2015-2017.

Dr. Doolittle currently serves as a member of the Board of Equity, Diversity, and Inclusion for the Banff International Research Station and as a founding member of the Canadian Mathematical Society's Committee on Reconciliation in Mathematics. In addition, he makes regular invited visits to educational institutions across Canada where he shares freely his experiences and his wisdom on matters related to Indigenous knowledge and Indigenizing education.

Dr. Doolittle's exceptional contributions to mathematics education make him a most deserving recipient of the 2023 Adrien Pouliot Award.

PRIX ADRIEN POULIOT

La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Dr Edward Doolittle est le récipiendaire du prix Adrien Pouliot 2023 en reconnaissance de sa contribution exceptionnelle à l'enseignement des mathématiques. Ce prix lui sera remis lors de la Réunion d'hiver 2023 de la SMC.

M. Doolittle est Kanyen'kehake, membre de la bande *Lower Mohawk* des *Six Nations*. Il a obtenu un doctorat en mathématiques pures de l'Université de Toronto en 1997 avec une thèse sur les équations différentielles partielles. Depuis 2001, il est membre de la faculté de l'Université des Premières Nations du Canada (anciennement le *Saskatchewan Indian Federated College*). Ses fonctions comprennent l'enseignement, la recherche, la collaboration avec les aînés, et le service à l'université et aux communautés autochtones.

M. Doolittle est un spécialiste internationalement reconnu des mathématiques autochtones et des concepts connexes tels que l'autochtonisation des mathématiques, les mathématiques traditionnelles et les ethnomathématiques. Depuis deux décennies, il travaille sans relâche pour nous faire découvrir les façons dont les mathématiques en tant que domaine d'étude se recoupent avec les systèmes de connaissances autochtones, ainsi que les possibilités d'enseignement offertes par ces différentes conceptions des mathématiques. Pour ce faire, il a notamment dirigé des groupes de travail lors du Forum sur l'enseignement des mathématiques de la SMC en 2005, il a prononcé une allocution plénière lors de la réunion annuelle du Groupe canadien d'étude en didactique des mathématiques (GCEDM) en 2006, a dirigé un groupe de travail lors de la réunion annuelle du GCEDM en 2010, a joué un rôle clé dans une série d'ateliers de la BIRS consacrés aux mathématiques des Premières nations, a participé à des projets de recherche avec des chercheurs en éducation, a publié des articles dans des revues et des ouvrages sur l'éducation et a mené de nombreuses actions de sensibilisation auprès de la population locale.

Voix discrète mais passionnée du changement, Dr. Doolittle travaille aux niveaux national, provincial et local. Il a également été membre de *Revisioning, Reclaiming, Reconciling School Mathematics*, un groupe d'universitaires, d'éducateurs et d'administrateurs qui élaborent des propositions de programmes d'études et de politiques en mathématiques autochtones pour le prochain cycle de révision des programmes d'études en mathématiques de la maternelle à la 12e année en Saskatchewan, de 2015 à 2018, membre du comité de restructuration académique de l'Université des Premières Nations, de 2016 à 2018, et secrétaire-trésorier de la Fondation du patrimoine autochtone du Canada, de 2015 à 2017.

Dr Doolittle est actuellement membre du conseil *Equity, Diversity and Inclusion* de la Station internationale de recherche de Banff et membre fondateur du Comité sur la réconciliation en mathématiques de la SMC. De plus, il est régulièrement invité à visiter des établissements d'enseignement à travers le Canada, où il partage librement ses expériences et sa sagesse sur les questions liées au savoir autochtone et à l'autochtonisation de l'éducation.

Les contributions exceptionnelles du Dr Doolittle à l'enseignement des mathématiques font de lui un lauréat très digne du prix Adrien Pouliot 2023.

G. DE B. ROBINSON AWARD

The Canadian Mathematical Society (CMS) is pleased to announce Dr. Hector Pasten (Pontificia Universidad Catolica de Chile) as the recipient of the 2023 G. de B. Robinson Award for a paper published in the Canadian Mathematical Bulletin.

Dr. Pasten is receiving the award for his paper "*Arithmetic derivatives through geometry of numbers*" (Canadian Mathematical Bulletin, 65(4), 906-923. doi:10.4153/S0008439521000990).

This paper exhibits in concrete terms an analogy between derivatives in function fields, and phenomena in the geometry of numbers. Specifically, this work defines a certain class of arithmetic derivatives on the ring of integers, and shows that the existence of "small" arithmetic derivatives is equivalent to the abc Conjecture of Masser and Oesterlé. A major contribution to the Vojta dictionary between Diophantine geometry and Nevanlinna theory, this paper is sure to be a significant influence on further research in the field.

Dr. Hector Pasten is a Chilean mathematician. His research area is number theory and its connections with logic, complex analysis, and algebraic geometry. He graduated in 2014 from Queen's University (Canada) under the supervision of Ram Murty and spent the period 2014-2018 at Harvard as a Benjamin Peirce Fellow, with a stay at the Institute for Advanced Study at Princeton (2015-2016). In 2018 he joined the faculty of Mathematics at Pontificia Universidad Catolica de Chile, where he is now an associate professor. Pasten's research has been recognized with several honors such as the Governor General of Canada Academic Gold Medal (2014) the Doctoral Prize of the CMS (2015) and the Mathematical Council of the Americas Prize (2017).

PRIX G. DE B. ROBINSON

La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Dr Hector Pasten (*Pontificia Universidad Catolica de Chile*) est le lauréat du prix G. de B. Robinson pour un article publié dans le Bulletin canadien de mathématiques.

Dr Pasten reçoit le prix pour son article "*Arithmetic derivatives through geometry of numbers*"
(Bulletin canadien de mathématiques, 65(4), 906-923.
doi:10.4153/S0008439521000990).

Cet article présente en termes concrets une analogie entre les dérivées dans les champs de fonctions et les phénomènes de la géométrie des nombres. Plus précisément, ce travail définit une certaine classe de dérivées arithmétiques sur l'anneau des entiers, et montre que l'existence de "petites" dérivées arithmétiques est équivalente à la conjecture abc de Masser et Oesterlé. Contribution majeure au dictionnaire de Vojta entre la géométrie diophantienne et la théorie de Nevanlinna, cet article ne manquera pas d'influencer de manière significative les recherches ultérieures dans ce domaine.

Dr Hector Pasten est un mathématicien chilien. Son domaine de recherche est la théorie des nombres et ses liens avec la logique, l'analyse complexe et la géométrie algébrique. Diplômé en 2014 de l'Université Queen's (Canada) sous la direction de Ram Murty, il a passé la période 2014-2018 à Harvard en tant que *Benjamin Peirce Fellow*, avec un séjour à l'*Institute for Advanced Study* de *Princeton* (2015-2016). En 2018, il a rejoint la faculté de mathématiques de la *Pontificia Universidad Catolica* de *Chile*, où il est aujourd'hui professeur associé. Les recherches de Pasten ont été récompensées par plusieurs distinctions telles que la médaille d'or académique du Gouverneur général du Canada (2014), le prix doctoral de la SMC (2015) et le prix *Mathematical Council of the Americas* (2017).

List of Abbreviations
Liste des abbréviations

AdvMatT	Advancements in Matrix Theory with Applications Advancements in Matrix Theory with Applications
AlgAriG	Algebraic, Arithmetic and Kahler Geometry: Recent developments Algebraic, Arithmetic and Kahler Geometry: Recent developments
AlgEnCo	Algebraic and Enumerative Combinatorics Combinatoires algébrique et énumérative
AlgGrTh	Algebraic Graph Theory for Walking on Graphs Théorie algébrique des graphes pour la marche sur les graphes
AutoRep	Automorphic representations and p-adic aspects of the Langlands program Représentations automorphes et aspects p-adiques du programme de Langlands
CluAlgR	Cluster Algebras in Representation Theory Les groupes d'algèbres dans la théorie des représentations
ComDe	Combinatorial Design Theory Théorie de la conception combinatoire
ComGSpe	Computational and Geometric Spectral Theory Computational and Geometric Spectral Theory
CommAlg	Commutative Algebra Algèbre commutative
DeSetTh	Descriptive Set Theory Descriptive Set Theory
EdPlen	Education Plenary Conférence plénière sur l'éducation
FunAnTo	Functional Analytic tools for Financial Decision Making Outils d'analyse fonctionnelle pour la prise de décision financière
GeoCalc	Geometry in Calculus of Variations and PDEs Geometry in Calculus of Variations and PDEs
GeoFunA	Geometric Functional Analysis: Analytic, Discrete, and Probabilistic Aspects Analyse fonctionnelle géométrique : Aspects analytiques, discrets et probabilistes
GeomAn	Geometric Analysis Analyse géométrique
GeoPDE	Geometric Partial Differential Equations Équations géométriques différentielles partielles
HarmPDE	Harmonic Analysis & PDE Harmonic Analysis & PDE
HomThe	Homotopy Theory Théorie d'homotopie
JMD	A celebration in honor of Jean-Marie De Koninck's 75th birthday: Elementary and Analytic Number Theory Théorie élémentaire et analytique des nombres : Une célébration à l'honneur du 75ème anniversaire de Jean-Marie de Koninck
MaMach	Mathematics of Machine Learning Les mathématiques de l'apprentissage automatique
MatGrCo	Current Trends in Matrices, Graphs and Computing Tendances actuelles dans les matrices, les graphes et l'informatique
MathPub	Mathematics in the Public Sector Mathematics in the Public Sector
MMSPDE	Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations
MSAIMod	Mathematical, statistical, and AI modelling of Mpox and related diseases. Modélisation mathématique, statistique et IA du Mpox et des maladies associées

NumTheo	Number Theory by early career researchers
	Number Theory by early career researchers
Plenary	Plenary Lectures
	Conférences plénières
Poster	AARMS-CMS Student Poster Session
	Présentations par affiches des étudiants - AARMS-SMC
Prize	Adrien Pouliot Award
	Prix Adrien-Pouliot
Prize	Coxeter-James Prize
	Prix Coxeter-James
Prize	Doctoral Prize
	Prix de doctorat
Public	Public Mitacs Lecture
	Conférence publique Mitacs
RanMatT	The many facets of random matrix theory
	The many facets of random matrix theory
SRS	Student Research Session
	Séance de recherche étudiante
StatMec	Recent Progress in Statistical Mechanics
	Recent Progress in Statistical Mechanics
StochCo	Stochastic Control Theory and Applications
	Théorie du contrôle stochastique et ses applications
SupNum	Supporting Numeracy for Non-STEM Students
	Supporter la numératie pour les étudiants non-STIM
VivMath	Viv(r)e les mathématiques
	Viv(r)e les mathématiques
WavePh	Wave Phenomena and Partial Differential Equations
	Wave Phenomena and Partial Differential Equations

Schedule for Business Meetings
Horaire pour Séances de travail

Friday December 1	vendredi 1er décembre
12:30 - 16:30	CMS Board of Directors Meeting / Réunion du Conseil d'administration SMC, Symphonie 3

Saturday December 2	samedi 2 décembre
10:30 - 13:30	Publications Committee / Comité des publications, Symphonie 5
10:30 - 14:30	Student Committee / Comité des étudiants, Symphonie 6

Sunday December 3	dimanche 3 décembre
12:00 - 15:00	Mathematical Competitions Committee / Comité des concours mathématiques, Symphonie 5

Schedule for Related Activities
Horaire pour Activités sociales

Friday December 1 — vendredi 1er décembre

16:45 - 17:00	Opening and Welcome / Ouverture et bienvenue, Grand Salon Opera AB
18:00 - 19:30	Welcome Reception / Réception de bienvenue, Grand Salon Opera Foyer

Saturday December 2 — samedi 2 décembre

10:30 - 11:00	Break / Pause, Grand Salon Opera Foyer
14:30 - 15:00	Break / Pause, Grand Salon Opera Foyer
15:00 - 16:30	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Grand Salon Opera Foyer
19:00 - 21:00	Student Social / Soirée étudiante, Vieux Dublin

Sunday December 3 — dimanche 3 décembre

10:30 - 11:00	Break / Pause, Grand Salon Opera Foyer
14:30 - 15:00	Break / Pause, Grand Salon Opera Foyer
19:00 - 22:00	Awards Banquet / Banquet de prix, Inspiration

Monday December 4 — lundi 4 décembre

10:30 - 11:00	Break / Pause, Grand Salon Opera Foyer
14:30 - 15:00	Break / Pause, Grand Salon Opera Foyer

Schedule
Horaire

Friday December 1	**vendredi 1er décembre**
16:45 - 17:00	Opening and Welcome / Ouverture et bienvenue, Activ, Grand Salon Opera AB
17:00 - 18:00	Yoshua Bengio (Université de Montréal, and the Founder and Scientific Director of Mila – Quebec AI Institute), *Mathematical challenges towards safe AI*, Public (p. 40), Grand Salon Opera AB
18:00 - 19:30	Welcome Reception / Réception de bienvenue, Activ, Grand Salon Opera Foyer

Saturday December 2 — samedi 2 décembre

8:00 - 8:30 Peter Bubenik (University of Florida), *Homotopy and persistent homology using closure spaces*, HomThe (p. 129), Symphonie 3A

8:00 - 8:30 Erman Isik (University of Ottawa), *Modular approach to Diophantine equation $x^p + y^p = z^3$ over some number fields*, NumTheo (p. 155), Grand Salon Opera B

8:00 - 8:30 Arvind Kumar (New Mexico State University), *Resurgence of Classical Varieties*, CommAlg (p. 86), Maestro

8:00 - 8:30 Nguyen H. Lam (Memorial University, Canada), *A new approach to weighted Hardy-Rellich inequalities*, GeoFunA (p. 112)

8:00 - 8:30 Sam Payne (University of Texas), *Cohomology groups of moduli spaces of curves*, AlgAriG (p. 66), Symphonie 2B

8:00 - 8:30 Somnath Pradhan (Queen's University), *Existence and Discrete-Time Approximations of Optimal Controls for Controlled Diffusions under General Information Structures*, StochCo (p. 164), UQAM - PK-1320

8:00 - 8:30 Ryan Thiessen (Alberta), *Travelling Wave Solutions in a Novel Glioma Invasion Model.*, MMSPDE (p. 150), UQAM - PK-2605

8:00 - 8:30 Gantumur Tsogtgerel (McGill University), *Elliptic estimates for operators with rough coefficients*, WavePh (p. 183), UQAM - PK-7210

8:00 - 8:30 William Verreault (University of Toronto), *On the tower factorization of integers*, JMD (p. 47), Symphonie 4B

8:00 - 8:40 Min Chen (McGill University), *Alexandrov-Fenchel type inequalities for hypersurfaces in the sphere*, GeomAn (p. 106), Symphonie 4A

8:30 - 9:00 Minerva Catral (Xavier University), *Spectral properties of a structured matrix related to a system of second order ODEs*, AdvMatT (p. 49), Creation

8:30 - 9:00 Graham Cox (Memorial University), *Geometry and topology of spectral minimal partitions*, ComGSpe (p. 90)

8:30 - 9:00 Paul Gauthier (Université de Montréal), *Radial limits of solutions to elliptic partial differential equations*, HarmPDE (p. 123), Ovation

8:30 - 9:00 Tiziana Giorgi (University of Alabama), *SmA-type phases of bent-core liquid crystals*, GeoCalc (p. 119), Symphonie 7

8:30 - 9:00 Chris Godsil (University of Waterloo), *Periodicity of Oriented Cayley Graphs*, MatGrCo (p. 95)

8:30 - 9:00 Benoit Hamelin (Tutte Institute for Mathematics and Computing), *Telemetry representation and interactive labeling to facilitate cyber defense*, MathPub (p. 138), UQAM - PK-6605

8:30 - 9:00 Minyi Huang (Carleton University), *Mean field social optimization: person-by-person optimality and master equations*, StochCo (p. 164), UQAM - PK-1320

8:30 - 9:00 Vishesh Jain (University of Illinois at Chicag), *Invertibility of random matrices*, RanMatT (p. 177), Imagination

8:30 - 9:00 Benjamin Landon (University of Toronto), *Tail estimates for stationary KPZ models*, StatMec (p. 159), Symphonie 3B

8:30 - 9:00 Alan Lindsay (Notre Dame), *Inferring the source of diffusive sources through extreme statistics.*, MMSPDE (p. 148), UQAM - PK-2605

8:30 - 9:00 Jonathan Love (McGill University), *On isospectral quaternion orders*, NumTheo (p. 156), Grand Salon Opera B

8:30 - 9:00 Steven Lu (UQAM), *Rigidity of maps into moduli space of polarized varieties*, AlgAriG (p. 66), Symphonie 2B

8:30 - 9:00 Bill Martin (WPI), *Delsarte designs in finite groups*, ComDe (p. 80), Soprano C

8:30 - 9:00 Ming Mei (McGill University & Champlain College St-Lamberta), *Threshold convergence results for nonlocal time-delayed diffusion equations*, WavePh (p. 182), UQAM - PK-7210

8:30 - 9:00 John Miller (Université de Montréal), *Persistence and Triangulated Categories*, HomThe (p. 132), Symphonie 3A

8:30 - 9:00 Shah Roshan-Zamir (University of Nebraska-Lincoln), *Interpolation in the Weighted Projective Space*, CommAlg (p. 87), Maestro

8:30 - 9:00 Gary Walsh (University of Ottawa), *Powerful Numbers, Elliptic Curves and other Keywords*, JMD (p. 47), Symphonie 4B

8:30 - 9:00 Zengle Zhang (Chongquing University of Arts and Sciences, China), *The dual Orlicz-Minkowski problems for log-concave functions*, GeoFunA (p. 115)

8:30 - 11:00	Eva Knoll (Université du Québec à Montréal), *Viv(r)e les mathématiques*, VivMath (p. 180), Grand Salon Opera A
8:50 - 9:30	Sebastien Picard (University of British Columbia), *Strominger system and complex geometry*, GeomAn (p. 107), Symphonie 4A
9:00 - 9:30	Nicholas Barnfield (McGill University), *On the Ziv-Merhav theorem beyond Markovianity*, StatMec (p. 158), Symphonie 3B
9:00 - 9:30	Kübra Benli (University of Lethbridge), *Discrete moments of the derivatives of the Riemann zeta function*, NumTheo (p. 153), Grand Salon Opera B
9:00 - 9:30	Romain Branchereau (McGill), *Toroidal integrals of Kudla-Millson forms and diagonal restrictions of Hilbert modular forms*, AutoRep (p. 69), UQAM - PK-2205
9:00 - 9:30	Jade Brisson (Université de Neuchâtel), *Tubes and Steklov eigenvalues in negatively curved manifolds*, ComGSpe (p. 90)
9:00 - 9:30	Simone Brugiapaglia (Concordia University), *Generalization limits of deep neural networks in identity effects learning*, MaMach (p. 142), Soprano A
9:00 - 9:30	Asaf Cohen (University of Michigan), *Deep Neural Networks Methods for Mean Field Game Master Equation*, StochCo (p. 163), UQAM - PK-1320
9:00 - 9:30	Thiago de Holleben (Dalhousie University), *Rees algebras and Lefschetz properties of squarefree monomial ideals*, CommAlg (p. 85), Maestro
9:00 - 9:30	Chi Hoi (Kyle) Yip (University of British Columbia), *Diophantine tuples over integers and finite fields*, JMD (p. 45), Symphonie 4B
9:00 - 9:30	Joel Kamnitzer (McGill), *Cluster algebras, MV polytopes, and MV cycles*, CluAlgR (p. 74), Inspiration Room
9:00 - 9:30	Damir Kinzebulatov (Université Laval), *An Orlicz space dictated by drifts singularities*, HarmPDE (p. 124), Ovation
9:00 - 9:30	Raphael Madou (McGill), *Strong solutions on SDEs with singular (form-bounded) drifts via Rockner-Zhao approach.*, MMSPDE (p. 148), UQAM - PK-2605
9:00 - 9:30	Udit Mavinkurve (University of Western Ontario), *The Fundamental Group(oid) in Discrete Homotopy Theory*, HomThe (p. 131), Symphonie 3A
9:00 - 9:30	Luka Milic (Toronto Metropolitan University), *Investment Strategies in the Face of Climate Uncertainty: Balancing Transition and Physical Risks*, FunAnTo (p. 104), UQAM - SH - 3260
9:00 - 9:30	James Mingo (Queen's University), *Infinitesimal Operators*, RanMatT (p. 178), Imagination
9:00 - 9:30	Debaditya Raychaudhury (University of Arizona), *On the singularities of secant varieties*, AlgAriG (p. 66), Symphonie 2B
9:00 - 9:30	Kianoosh Shokri (Ottawa), *Improving upper bounds on the size of some covering arrays of strength 3*, ComDe (p. 82), Soprano C
9:00 - 9:30	Marcin Sroka (CRM), *On the conjecture of Alesker-Verbitsky*, GeoPDE (p. 118), Symphonie 2A
9:00 - 9:30	Dominik Stantejsky (McMaster University), *On Minimizing Harmonic Maps with Planar Boundary Anchoring*, GeoCalc (p. 120), Symphonie 7
9:00 - 9:30	Michael Tait (Villinova), *The largest eigenvalue of the normalized distance Laplacian matrix*, MatGrCo (p. 99)
9:00 - 9:30	Sichun Wang (Defence Research and Development Canada), *Miscellaneous Applications of Mathematics and Statistics in Statistical Signal Processing and White-Box Cryptography*, MathPub (p. 140), UQAM - PK-6605
9:00 - 9:30	Amy Yielding (Eastern Oregon University), *An Investigation of Coefficient Sign Arbitrary Patterns*, AdvMatT (p. 52), Creation
9:00 - 9:30	Xinwei Yu (University of Alberta), *Some new regularity criterions for the 3D incompressible Navier-Stokes equations*, WavePh (p. 183), UQAM - PK-7210
9:00 - 9:30	Yiming Zhao (Syracuse University, USA), *The Minkowski problem in Gaussian probability space*, GeoFunA (p. 115)
9:30 - 10:00	Jose Palacios Armesto (University of Toronto), *Asymptotic Stability of peakons for the Novikov equation*, WavePh (p. 181), UQAM - PK-7210
9:30 - 10:00	Jane Breen (Ontario Tech University), *A structured condition number for Kemeny's constant*, AdvMatT (p. 49), Creation

9:30 - 10:00 Peter Caines (McGill University), *Mean Field Games on Large Sparse and Dense Networks*, StochCo (p. 162), UQAM - PK-1320

9:30 - 10:00 Carrie Clark (University of Illinois Urbana Champaign), *Droplet formation in a simple nonlocal aggregation model*, HarmPDE (p. 123), Ovation

9:30 - 10:00 Matt Davison (Western University), *Data Science Insights and financial models about the Financial Behaviour of Canadians*, FunAnTo (p. 103), UQAM - SH - 3260

9:30 - 10:00 Ertan Elma (University of Lethbridge), *Number of Prime Factors with a Given Multiplicity*, NumTheo (p. 154), Grand Salon Opera B

9:30 - 10:00 Tom Gannon (UCLA), *Proof of the Ginzburg-Kazhdan conjecture*, CluAlgR (p. 73), Inspiration Room

9:30 - 10:00 Adam Gardner (Artinus Consulting), *Decoding Neural Scaling Laws*, MaMach (p. 143), Soprano A

9:30 - 10:00 Raphaël Grondin (McGill University), *A different approach to the Ziv-Merhav Theorem*, StatMec (p. 159), Symphonie 3B

9:30 - 10:00 Bin Guo (Rutgers), *Geometric estimates in Kähler geometry*, GeoPDE (p. 117), Symphonie 2A

9:30 - 10:00 Kennedy Idu (University of Toronto), *On the Alexandrov's estimate*, GeoCalc (p. 120), Symphonie 7

9:30 - 10:00 Erman Isik, *On anticyclotomic Iwasawa theory of Hecke characters for ordinary primes*, AutoRep (p. 70), UQAM - PK-2205

9:30 - 10:00 David Kribs (University of Guelph), *Chordal Graphs and Distinguishability of Quantum States*, MatGrCo (p. 96)

9:30 - 10:00 Sun-Kai Leung (Université de Montréal), *Central limit theorems for arithmetic functions in short intervals*, JMD (p. 46), Symphonie 4B

9:30 - 10:00 Greg Lewis (UOIT), *Numerical continuation for sheared annular electroconvection*, MMSPDE (p. 148), UQAM - PK-2605

9:30 - 10:00 Rachel Hardeman Morrill (University of Calgary), *Path Categories and Graphs*, HomThe (p. 132), Symphonie 3A

9:30 - 10:00 Michael Morrow (University of Kentucky), *Syzygy Computations in OI-Modules*, CommAlg (p. 87), Maestro

9:30 - 10:00 Masoud M Nasari (Bank of Canada), *Disaggregating low-frequency economic measures*, MathPub (p. 139), UQAM - PK-6605

9:30 - 10:00 Guillermo Nunez Ponasso (WPI), *Maximal determinants of matrices with entries in the roots of unity*, ComDe (p. 81), Soprano C

9:30 - 10:00 David Renfrew (Binghamton University), *Eigenvalues of minors of random matrices and roots of derivatives of random polynomials*, RanMatT (p. 179), Imagination

9:30 - 10:00 Ethan Ross (University of Toronto), *Singular Reduction of Polarizations*, AlgAriG (p. 67), Symphonie 2B

9:30 - 10:00 Craig Sutton (Dartmouth), ComGSpe (p. 92)

9:30 - 10:00 Chengjun Yue (Memorial University, Canada), *Around Poisson-Bessel potentials of fractional L^1-Hardy-Sobolev spaces*, GeoFunA (p. 114)

9:40 - 10:20 Chao-Ming Lin (Ohio State University), *On the solvability of general inverse σ_k equations*, GeomAn (p. 107), Symphonie 4A

10:00 - 10:30 Toni Annala (Institute for Advanced Study, Princeton), *Topologically protected tricolorings*, HomThe (p. 129), Symphonie 3A

10:00 - 10:30 Susan Cooper (University of Manitoba), *Resolutions & Powers of Ideals*, CommAlg (p. 85), Maestro

10:00 - 10:30 Mihir Deo (University of Ottawa), *Signed p-adic L-functions of Bianchi modular forms*, NumTheo (p. 153), Grand Salon Opera B

10:00 - 10:30 Gael Yomgne Diebou (University of Toronto), *Non-blow up at large times and stability of global solutions to nematic liquid crystal flow*, WavePh (p. 182), UQAM - PK-7210

10:00 - 10:30 Diane Guignard (University of Ottawa), *Finite Element Methods for the Stretching and Bending of Thin Structures with Folding*, GeoCalc (p. 119), Symphonie 7

10:00 - 10:30 Changho Han (University of Waterloo), *Extending Torelli map from Smyth's alternative compactifications of the moduli of curves*, AlgAriG (p. 65), Symphonie 2B

10:00 - 10:30 Joe Jackson (University of Chicago), *Sharp convergence rates for mean field control on the region of strong regularity*, StochCo (p. 164), UQAM - PK-1320

10:00 - 10:30 Omar Kihel (Brock University), *On the index of a number field and some connected open questions*, JMD (p. 46), Symphonie 4B

10:00 - 10:30	Hanna Kim (Illinois), *Upper Bound on the Second Laplacian Eigenvalue on the Real Projective Space*, ComGSpe (p. 90)
10:00 - 10:30	Alexander Koldobsky (University of Missouri, USA), *Comparison problems for the Radon transform*, GeoFunA (p. 112)
10:00 - 10:30	Theodore Kolokolnikov (Dalhousie), *Recurrent and chaotic outbreaks in SIR model*, MMSPDE (p. 147), UQAM - PK-2605
10:00 - 10:30	Erin Meger (Queen's University), *The Spectral Gap of Iterative Complex Networks*, AdvMatT (p. 51), Creation
10:00 - 10:30	Paul Mezo (Carleton), *Arthur packets for real unitary groups*, AutoRep (p. 71), UQAM - PK-2205
10:00 - 10:30	Ahmad Mojallal (University of Regina), *Forts, (fractional) zero forcing, and Cartesian products of graphs*, MatGrCo (p. 97)
10:00 - 10:30	Gilles Parez (Université de Montréal), *The range of entanglement*, StatMec (p. 159), Symphonie 3B
10:00 - 10:30	Question and Answer Period, MathPub (p. 139), UQAM - PK-6605
10:00 - 10:30	Cristian Rios (University of Calgary), *The Moser method for infinitely degenerate equations*, HarmPDE (p. 125), Ovation
10:00 - 10:30	Luana Ruiz (Johns Hopkins University), *Machine Learning on Large-Scale Graphs*, MaMach (p. 144), Soprano A
10:00 - 10:30	Mateja Sajna (Ottawa), *A recursive construction of solutions to the directed Oberwolfach problem*, ComDe (p. 81), Soprano C
10:00 - 10:30	Samuel Solgon Santos (University of Waterloo), *Inducing comonotonic additive risk measures from acceptance sets*, FunAnTo (p. 104), UQAM - SH - 3260
10:00 - 10:30	Aaron Smith (University of Ottawa), *Kac's Walk on SO(n) and Related Chains*, RanMatT (p. 179), Imagination
10:00 - 10:30	Freid Tong (Harvard), *On a free boundary Monge-Ampere equation and complete Calabi-Yau metrics*, GeoPDE (p. 118), Symphonie 2A
10:00 - 10:30	Kayla Wright (UMN), *Higher Dimers, Webs and Grassmannian Cluster Algebras*, CluAlgR (p. 76), Inspiration Room
10:30 - 11:00	Break / Pause, Activ, Grand Salon Opera Foyer
11:00 - 12:00	Déborah Oliveros (UNAM), *From classical geometry to new constructions of bodies of constant width*, Plenary (p. 42), Grand Salon Opera AB
13:30 - 14:30	Edward Doolittle (First Nations University of Canada), Prize (p. 43), Grand Salon Opera AB
14:30 - 15:00	Break / Pause, Activ, Grand Salon Opera Foyer
15:00 - 16:30	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Activ, Grand Salon Opera Foyer
15:00 - 15:30	Sedanur Albayrak (University of Calgary), *Quantitative estimates for the size of an intersection of sparse automatic sets*, NumTheo (p. 153), Grand Salon Opera B
15:00 - 15:30	Elena Braverman (University of Calgary), *Trimming harvesting strategies to natural dispersal for spatially heterogeneous populations*, WavePh (p. 181), UQAM - PK-7210
15:00 - 15:30	Alex Chernyavsky (Buffalo), *Whitham modulation theory for the Zakharov-Kuznetsov equation and stability analysis of its periodic traveling wave solutions*, MMSPDE (p. 147), UQAM - PK-2605
15:00 - 15:30	Shih-Kai Chiu (Vanderbilt), *Special Lagrangian spheres in adiabatic limits*, GeoPDE (p. 116), Symphonie 2A
15:00 - 15:30	Christina Christara (University of Toronto), *Properties of matrices arising from Black-Scholes equations*, AdvMatT (p. 49), Creation
15:00 - 15:30	Giorgio Cipolloni (Princeton University), *Logarithmically correlated fields in non-Hermitian random matrices*, RanMatT (p. 176), Imagination
15:00 - 15:30	Aleksander Danielski (Concordia University), *Complex Analytic Structure of Stationary Solutions of the Euler Equations*, HarmPDE (p. 123), Ovation
15:00 - 15:30	Alexander Fribergh (Université de Montréal), *Biased random walks on supercritical percolation clusters*, StatMec (p. 159), Symphonie 3B
15:00 - 15:30	Geneviève Gauthier (HEC Montréal), *Joint dynamics for the underlying asset and its implied volatility surface: A new methodology for option risk management*, FunAnTo (p. 103), UQAM - SH - 3260

15:00 - 15:30 Ryan Gibara (U. Cincinatti, USA), *Traces and extensions of Sobolev functions in metric measure spaces*, GeoFunA (p. 111)

15:00 - 15:30 Simon Henry (University of Ottawa), *Simplicial completion of model categories and strictification*, HomThe (p. 130), Symphonie 3A

15:00 - 15:30 Mark Iwen (Michigan State University), *Sparse Spectral Methods for Solving High-Dimensional and Multi-scale Elliptic PDEs*, MaMach (p. 143), Soprano A

15:00 - 15:30 Sumun Iyer (Cornell University), *Generic homeomorphisms of Knaster continua*, DeSetTh (p. 100), Symphonie 1

15:00 - 15:30 Koray Karabina (National Research Council Canada), *Cryptography Meets Topological Data Analysis*, MathPub (p. 138), UQAM - PK-6605

15:00 - 15:30 Hasan Mahmood (Dalhousie University), *Mutation of Simplicial Complexes*, CommAlg (p. 87), Maestro

15:00 - 15:30 Hermie Monterde (University of Manitoba), *Quantum walks on join graphs*, MatGrCo (p. 97)

15:00 - 15:30 Jeff Ovall (Portland State), *Concerning the localization of eigenvectors for the magnetic Laplacian operator*, ComGSpe (p. 91)

15:00 - 15:30 Mishty Ray (Calgary), *Vogan's conjecture for p-adic GL_n*, AutoRep (p. 71), UQAM - PK-2205

15:00 - 15:30 Zinovy Reichstein (UBC), *Essential dimension of symmetric groups in prime characteristic*, AlgAriG (p. 67), Symphonie 2B

15:00 - 15:30 Cihan Sabuncu (Université de Montréal), *On the moments of the number of representations as sums of two prime squares*, JMD (p. 47), Symphonie 4B

15:00 - 15:30 Sina Sanjari (University of Illinois / Royal Military College), *Large Stochastic Exchangeable Teams, Their Mean-Field Limits, and Optimality of Symmetric Policies*, StochCo (p. 165), UQAM - PK-1320

15:00 - 15:30 Brett Stevens (Carleton), *Classification and enumeration of single change covering designs*, ComDe (p. 82), Soprano C

15:00 - 15:30 Karen Yeats (Waterloo), *T-duality by Le diagrams*, CluAlgR (p. 76), Inspiration Room

15:00 - 15:40 Robert Haslhofer (University of Toronto), *Free boundary minimal disks in convex balls*, GeomAn (p. 107), Symphonie 4A

15:30 - 16:00 Masoomeh Akbari (Ottawa), *The Generalized Honeymoon Oberwolfach Problem with variable small cycle lengths*, ComDe (p. 77), Soprano C

15:30 - 16:00 Dave Anderson (Ohio State University), *Refined transversality and equivariant positivity*, AlgAriG (p. 65), Symphonie 2B

15:30 - 16:00 Daniel Carranza (Johns Hopkins University), *Calculus of fractions for quasicategories*, HomThe (p. 129), Symphonie 3A

15:30 - 16:00 Hugo Chapdelaine (Université Laval), *Conditional convergence in the critical strip for lattice zeta functions associated to totally real fields*, JMD (p. 45), Symphonie 4B

15:30 - 16:00 Trung Chau (University of Utah), *Barile-Macchia resolutions for monomial ideals*, CommAlg (p. 85), Maestro

15:30 - 16:00 Malena Espanol (Arizona State University), *Variable Projection Methods for Separable Nonlinear Inverse Problems*, AdvMatT (p. 50), Creation

15:30 - 16:00 Kirill Golubnichiy (University of Calgary), *Inverse Problem for the Black-Scholes Equation solution.*, HarmPDE (p. 123), Ovation

15:30 - 16:00 Elias Hess-Childs (New York University), *Propagation of chaos from the perspective of perturbation theory*, StatMec (p. 159), Symphonie 3B

15:30 - 16:00 Spiro Karigiannis (University of Waterloo), *A special class of p-harmonic maps inducing calibrated fibrations*, GeoPDE (p. 117), Symphonie 2A

15:30 - 16:00 Chris Karpinski (McGill University), *Hyperfiniteness of boundary actions of groups*, DeSetTh (p. 101), Symphonie 1

15:30 - 16:00 Henry Kim (Toronto), *Distribution of Hecke eigenvalues for holomorphic Siegel modular forms*, AutoRep (p. 71), UQAM - PK-2205

15:30 - 16:00 Gregory Knapp (University of Calgary), *Polynomial Root Separation and Mahler Measure*, NumTheo (p. 155), Grand Salon Opera B

15:30 - 16:00 Benjamin Landon (University of Toronto), *Regularity conditions in the CLT for random matrices*, RanMatT (p. 177), Imagination

15:30 - 16:00 Yu Li (Toronto), *Integrable systems on the dual of nilpotent Lie subalgebras and T-Poisson cluster structures*, CluAlgR (p. 74), Inspiration Room

15:30 - 16:00 Wenjing Liao (Georgia Institute of Technology), *Exploiting low-dimensional structures in machine learning and PDE simulations*, MaMach (p. 143), Soprano A

15:30 - 16:00 Alexander Litvak (University of Alberta, Canada), *On the minimum of Gaussian variables.*, GeoFunA (p. 112)

15:30 - 16:00 William Martin (WPI), *Four-class Q-bipartite association schemes*, MatGrCo (p. 96)

15:30 - 16:00 Hanna Potgieter (SFU), *Numerical approximation of the first p-Laplace eigenpair for large p values*, ComGSpe (p. 91)

15:30 - 16:00 Mark Rempel (Defence Research and Development Canada), *Practical applications of reinforcement learning for decision support in defence and security*, MathPub (p. 139), UQAM - PK-6605

15:30 - 16:00 Danial Saadatmand (Brock), MMSPDE (p. 149), UQAM - PK-2605

15:30 - 16:00 Tony Ware (University of Calgary), *Operator splitting and optimal control of gas storage*, FunAnTo (p. 105), UQAM - SH - 3260

15:30 - 16:00 Johannes Wiesel (Carnegie Mellon University), *Martingale Schrödinger bridges*, StochCo (p. 166), UQAM - PK-1320

15:30 - 16:00 Yuanxi Yue (Memorial University of Newfoundland), *Traveling wavefronts to a model of precursor and differentiated cells*, WavePh (p. 183), UQAM - PK-7210

15:50 - 16:30 Ling Xiao (University of Connecticut), *Generalized Minkowski inequality via degenerate Hessian equations on exterior domains*, GeomAn (p. 107), Symphonie 4A

16:00 - 16:30 Anthony Bonato (Toronto Metropolitan University), *How to cool a graph*, MatGrCo (p. 95)

16:00 - 16:30 Lia Bronsard (McMaster University), *Boundary defects in liquid crystals/ Défauts aux limites dans les cristaux liquides*, StatMec (p. 158), Symphonie 3B

16:00 - 16:30 Sterling Ebel (University of Western Ontario), *Synthetic approach to the Quillen model structure on spaces*, HomThe (p. 130), Symphonie 3A

16:00 - 16:30 Eric Evert (Northwestern University), *Free extreme points of free spectrahedrops and generalized free spectrahedra*, AdvMatT (p. 50), Creation

16:00 - 16:30 Samprit Ghosh (University of Calgary), *Minimal Subfields of Elliptic curves*, NumTheo (p. 154), Grand Salon Opera B

16:00 - 16:30 Elena Guardo (University of Catania), *Expecting the unexpected: quantifying the persistence of unexpected hypersurfaces*, CommAlg (p. 86), Maestro

16:00 - 16:30 Katrina Honigs (SFU), *Hyperkahler varieties of Kummer type and torsion points of abelian surfaces*, AlgAriG (p. 65), Symphonie 2B

16:00 - 16:30 Martí Roset Julià (McGill), *Dihedral long root local A-packets of G_2 via theta correspondence*, AutoRep (p. 70), UQAM - PK-2205

16:00 - 16:30 Don Kreher (Michigan Tech), *Divisible and transverse Bussey systems*, ComDe (p. 79), Soprano C

16:00 - 16:30 Jonathan Li (University of Ottawa), *On Generalization and Regularization via Wasserstein Distributionally Robust Optimization*, FunAnTo (p. 104), UQAM - SH - 3260

16:00 - 16:30 Weiyang Li (Memorial University of Newfoundland), *Liouville-type Laws for $-\Delta_m u + |\nabla u|^q = f(u)$ in Exterior Domains of $\mathbb{R}^N$*, WavePh (p. 182), UQAM - PK-7210

16:00 - 16:30 Andras Meszaros (University of Toronto), *Eigenvectors of the square grid plus GUE*, RanMatT (p. 178), Imagination

16:00 - 16:30 Siva Nair (Université de Montréal), *The Mahler measure of some polynomial families*, JMD (p. 46), Symphonie 4B

16:00 - 16:30 Giangvuthanh Nguyen (Old Dominion University), *Asymptotic expansion of a singular potential near the nematic-isotropic phase transition point in the Landau-de Gennes theory*, HarmPDE (p. 124), Ovation

16:00 - 16:30 Koichi Oyakawa (Vanderbilt University), *Hyperfiniteness of boundary actions of acylindrically hyperbolic groups*, DeSetTh (p. 101), Symphonie 1

16:00 - 16:30 Theo Pinet (Institut de Mathématiques de Jussieu-Paris Rive Gauche), *Inflations for representations of shifted quantum affine algebras*, CluAlgR (p. 75), Inspiration Room

16:00 - 16:30 Valérie Poulin (Tutte Institute for Mathematics and Computing/Applied Research at Communications Security Establishment), *Hypergraph exploration via vectorization*, MathPub (p. 139), UQAM - PK-6605

16:00 - 16:30 Serge Prudhomme (Polytechnique Montreal), *Reduced-order modeling for the wave equation using Green's functions and neural networks*, MaMach (p. 144), Soprano A

16:00 - 16:30 Zachary Selk (Queen's University), *Robustness for Near-Brownian Noise via Rough Paths Theory*, StochCo (p. 165), UQAM - PK-1320

16:00 - 16:30 Rui Sun (University of Alberta, Canada), *Measure of Axiality for Convex Figures*, GeoFunA (p. 114)

16:00 - 16:30 Daniel Venn (SFU), *Surface Partial Differential Equation Solvability and Eigenvalues with Symmetric Mesh-free Methods*, ComGSpe (p. 92)

16:00 - 16:30 Thomas Wolf (Brock), *Radial compressible fluid flow in $n > 1$ dimensions and their conserved integrals, invariants, symmetries and Casimirs*, MMSPDE (p. 151), UQAM - PK-2605

16:00 - 16:30 Xinrui Zhao (MIT), *Unique continuation problem on RCD spaces*, GeoPDE (p. 118), Symphonie 2A

16:30 - 17:00 Nasrin Altafi (Queen's University), *The Weak Lefschetz property and the number of generators of equigenerated monomial ideals*, CommAlg (p. 84), Maestro

16:30 - 17:00 Stephen Anco (Brock), *Exact solitary wave solutions for a coupled gKdV-NLS system*, MMSPDE (p. 146), UQAM - PK-2605

16:30 - 17:00 Félix Baril.Boudreau (University of Lethbridge), *Value-Distribution of Logarithmic Derivatives of Real Quadratic Dirichlet L-functions over the Projective Line*, NumTheo (p. 153), Grand Salon Opera B

16:30 - 17:00 Margaret Chapman (University of Toronto), *Risk-Aware Control Theory*, StochCo (p. 162), UQAM - PK-1320

16:30 - 17:00 Joshua Flynn (CRM/ISM and McGill University), *LIOUVILLE-TYPE RESULT FOR THE CR YAMABE EQUATION IN THE HEISENBERG GROUP*, HarmPDE (p. 123), Ovation

16:30 - 17:00 Evans Harrell (GIT), *Upper and lower bounds for eigenvalue gaps for Schrödinger operators and quantum graphs*, ComGSpe (p. 90)

16:30 - 17:00 Kamyar Khodamoradi (University of Regina), MatGrCo (p. 96)

16:30 - 17:00 Brock Klippenstein (University of Manitoba), *Numerical Solution of Non-Normal Coefficient Sylvester Equations for Partial Differential Equations*, AdvMatT (p. 50), Creation

16:30 - 17:00 Jehyun Lee (Michigan Tech), *Uniformly resolvable decompositions of $K_v - I$ into 5-stars*, ComDe (p. 80), Soprano C

16:30 - 17:00 Kenneth Moore (University of British Columbia), *Minimal reflective and folding symmetry of convex sets*, GeoFunA (p. 113)

16:30 - 17:00 Marlon Moresco (Concordia University), *Uncertainty Propagation and Dynamic Robust Risk Measures*, FunAnTo (p. 104), UQAM - SH - 3260

16:30 - 17:00 Christoph Ortner (University of British Columbia), *Efficient Parameterization of Many-body Interaction*, MaMach (p. 144), Soprano A

16:30 - 17:00 Luke Peilen (Temple University), *Local Laws and Fluctuations for Log Gases*, RanMatT (p. 178), Imagination

16:30 - 17:00 Arthur Bonkli Razafindrasoanaivolala (Université Laval), *Integers with a sum of co-divisors yielding a square*, JMD (p. 46), Symphonie 4B

16:30 - 17:00 Giovanni Rosso (Concordia), *Hirzebruch–Zagier cycles in p-adic families and adjoint L-values*, AutoRep (p. 71), UQAM - PK-2205

16:30 - 17:00 Benjamin Santos (Statistics Canada), *Multi-Party Privacy Preserving Record Linkage based on Circuit Private Set Intersection*, MathPub (p. 140), UQAM - PK-6605

16:30 - 17:00 Carlo Scarpa (UQAM), *The Einstein-Hilbert functional and K-stability*, AlgAriG (p. 67), Symphonie 2B

16:30 - 17:00 Israel Michael Sigal (University of Toronto), *Some Rigorous Results on Propagation of Quantum Information*, StatMec (p. 160), Symphonie 3B

16:30 - 17:00 Holger Teismann (Acadia University), *Dispersion as an obstruction to the bilinear control of Schrödinger equations*, WavePh (p. 182), UQAM - PK-7210

16:30 - 17:00 Carlos Gabriel Valenzuela (University of Regina), *Double cohomology and sphere triangulations*, HomThe (p. 133), Symphonie 3A

16:30 - 17:00 Milen Yakimov (Northeastern), *Finite generation and representation theory of quantum cluster algebras at roots of unity*, CluAlgR (p. 76), Inspiration Room

16:30 - 17:00 Jenna Zomback (University of Maryland), *Boundary actions of free semigroups*, DeSetTh (p. 102), Symphonie 1

16:40 - 17:20	Zihui Zhao (Johns Hopkins University), *Unique continuation and the singular set of harmonic functions*, GeomAn (p. 108), Symphonie 4A
17:00 - 17:30	Ziad Aldirany (Polytechnique Montreal), *Multi-Level Approach for Error Reduction in Physics-Informed Neural Networks*, MaMach (p. 141), Soprano A
17:00 - 17:30	George Shaohua Chen (Cape Breton University), *Improved blowup time estimate for fourth-order damped wave equation with strain term at arbitrary positive initial energy*, WavePh (p. 182), UQAM - PK-7210
17:00 - 17:30	Dena Firoozi (University of Montreal), *Risk-Sensitive Control and Mean Field Games: A Variational Approach*, StochCo (p. 163), UQAM - PK-1320
17:00 - 17:30	Hamed Hatami (McGill University), *Littlestone dimension and online learnability of partial matrices*, MatGrCo (p. 95)
17:00 - 17:30	Ting-Han Huang (Concordia), *Special values of triple product p-adic L-functions and p-adic Abel-Jacobi maps*, AutoRep (p. 70), UQAM - PK-2205
17:00 - 17:30	James Hughes (Duke), *Cluster Modular Groups of Braid Varieties*, CluAlgR (p. 74), Inspiration Room
17:00 - 17:30	Sacha Ikonicoff (University of Ottawa), *Quillen-Barr-Beck cohomology of divided power algebras over an operad*, HomThe (p. 131), Symphonie 3A
17:00 - 17:30	Melissa Keranen (Michigan Tech), *Decomposition of complete graphs into disconnected unicyclic graphs with six edges*, ComDe (p. 79), Soprano C
17:00 - 17:30	Florian Luca (Wits University), *On the index of friability*, JMD (p. 46), Symphonie 4B
17:00 - 17:30	Nicholas McCleerey (Purdue), *Singularities of m-subharmonic Functions*, GeoPDE (p. 117), Symphonie 2A
17:00 - 17:30	Maria Ntekoume (Concordia University), *Critical well-posedness for the derivative nonlinear Schrödinger equation on the line*, HarmPDE (p. 125), Ovation
17:00 - 17:30	Question and Answer Period, MathPub (p. 139), UQAM - PK-6605
17:00 - 17:30	Subham Roy (Université de Montréal), *Areal Mahler measure of multivariable polynomials*, NumTheo (p. 157), Grand Salon Opera B
17:00 - 17:30	David Sher (De Paul), *Bessel function zeroes and Polya's conjecture*, ComGSpe (p. 92)
17:00 - 17:30	Alexey Shevyakov (Saskatchewan), *New exact plasma equilibria with axial and helical symmetry*, MMSPDE (p. 150), UQAM - PK-2605
17:00 - 17:30	Sergio Da Silva (Virginia State University), *Cohen-Macaulay Toric Ideals of Graphs and Geometric Vertex Decomposition*, CommAlg (p. 88), Maestro
17:00 - 17:30	Spencer Unger (University of Toronto), *Circle squaring with algebraic irrational translations*, DeSetTh (p. 102), Symphonie 1
17:00 - 17:30	Luc Vinet (Université de Montréal), *Entanglement of free fermiom systems, signal processing and algebraic combinatorics*, StatMec (p. 160), Symphonie 3B
17:00 - 17:30	Bartlomiej Zawalski (Kent State, USA), *On star-convex bodies with rotationally invariant sections*, GeoFunA (p. 114)
17:00 - 17:30	Xiaohong Zhang (Université de Montreal), *Laplacian cospectral graphs*, AdvMatT (p. 53), Creation
17:00 - 17:30	Sasha Zotine (Queen's University), *Kawaguchi-Silverman Conjecture for Projective Bundles on Curves*, AlgAriG (p. 67), Symphonie 2B
17:30 - 18:00	Theophilus Agama (Université Laval), *On the joint work of Jean-Marie De Koninck and Imre Kátai*, JMD (p. 45), Symphonie 4B
17:30 - 18:00	Andrii Arman (University of Manitoba, Canada), *On some covering problems related to Borsuk's conjecture*, GeoFunA (p. 110)
17:30 - 18:00	Brandon Doherty (Florida State University), *Cubical Joyal model structures: recent and ongoing developments*, HomThe (p. 130), Symphonie 3A
17:30 - 18:00	Siyuan Lu (McMaster University), *Curvature estimates for semi-convex solutions of Hessian equations*, GeoPDE (p. 117), Symphonie 2A
17:30 - 18:00	Philippe-André Luneau (Université Laval), *Conservative Surrogate Models for Optimization with the Active Subspace Method*, MaMach (p. 143), Soprano A
17:30 - 18:00	Farnam Mansouri (University of Waterloo), MatGrCo (p. 96)
17:30 - 18:00	Ritika Nair (University of Kansas), *An Improved Terai-Yoshida Theorem*, CommAlg (p. 87), Maestro
17:30 - 18:00	Isabella Negrini (University of Toronto), *A Shintani map for rigid cocycles*, NumTheo (p. 156), Grand Salon Opera B

17:30 - 18:00	Monica Nevins (Ottawa), *Semisimple characters of fixed-point subgroups*, AutoRep (p. 71), UQAM - PK-2205
17:30 - 18:00	Borna Sayedana (McGill University), *Relative Almost Sure Regret Bounds for Certainty Equivalence Control of Markov Jump Systems*, StochCo (p. 165), UQAM - PK-1320
17:30 - 18:00	Jacob Shapiro (Princeton University), *Classification of disordered insulators in 1D*, StatMec (p. 160), Symphonie 3B
17:30 - 18:00	Forte Shinko (UC Berkeley), *Equivalence relations classifiable by Polish abelian groups*, DeSetTh (p. 101), Symphonie 1
17:30 - 18:00	Cody Stockdale (Clemson University), *On the $T1$ theorem for compactness of Calderón-Zygmund operators*, HarmPDE (p. 126), Ovation
17:30 - 18:00	Harmony Zhan (Worcester Polytechnic Institute), *Spectra of line digraphs and their applications*, AdvMatT (p. 53), Creation
19:00 - 21:00	Student Social / Soirée étudiante, Activ, Vieux Dublin

Sunday December 3 — dimanche 3 décembre

8:00 - 8:30 Gioacchino Antonelli (Courant Institute, USA), *Nonnegative curvature and existence of isoperimetric sets*, GeoFunA (p. 110)

8:00 - 8:30 Yunus Emre Demirci (Queen's University), *On Regularity and Ergodicity of Partially Observable Markov (Decision) Processes*, StochCo (p. 163), UQAM - PK-1320

8:00 - 8:30 Andrew Harder (Lehigh University), *Tropical homology and mirror symmetry*, AlgAriG (p. 65), Symphonie 2B

8:00 - 8:30 Networking Meet and Greet, SupNum (p. 174), Grand Salon Opera A

8:00 - 8:30 Todd Mullen (University of Prince Edward Island), *Pay it Backward*, MatGrCo (p. 98)

8:00 - 8:30 Elkin Ramírez (McMaster), *SYSTEMATIC SEARCH FOR EXTREME BEHAVIOUR IN 3D NAVIER-STOKES EQUATIONS BASED ON THE LADYZHENSKAYA-PRODI-SERRIN CONDITIONS*, MMSPDE (p. 149), UQAM - PK-2605

8:00 - 8:30 Ben Williams (University of British Columbia), *Looking for extraordinary involutions*, HomThe (p. 134), Symphonie 3A

8:00 - 8:30 Harmony Zhan (Worcester Polytechnic University), *ϵ-uniform mixing in discrete quantum walks*, AlgGrTh (p. 57), Symphonie 4B

8:00 - 8:30 Xiao Zhong (University of Waterloo), *Preimages Question for Surjective Endomorphisms on $(\mathbb{P}^1)^n$*, NumTheo (p. 157), Grand Salon Opera B

8:00 - 8:40 Tristan Collins (University of Toronto), *Uniqueness of Cylindrical Tangent Cones to some Special Lagrangians*, GeomAn (p. 106), Symphonie 4A

8:30 - 9:00 Maxime Fortier Bourque (UDM), *Two counterexamples to a conjecture of Colin de Verdière*, ComGSpe (p. 89)

8:30 - 9:00 Almut Burchard (University of Toronto), *On pointwise (non)-monotonicity of heat kernels for metrics on the two-sphere*, GeoFunA (p. 110)

8:30 - 9:00 Mike Cummings (McMaster University), *A Gröbner basis for regular nilpotent Hessenberg Schubert cells*, CommAlg (p. 85), Maestro

8:30 - 9:00 Angele Foley (Wilfrid Laurier), *H-Chromatic Symmetric Functions*, AlgEnCo (p. 62), Symphonie 3B

8:30 - 9:00 Michael Groechenig (University of Toronto), *p-adic integration, buildings and BPS invariants*, AlgAriG (p. 65), Symphonie 2B

8:30 - 9:00 Arnab Kundu (University of Toronto), *Gersten's injectivity in the non-Noetherian world*, HomThe (p. 131), Symphonie 3A

8:30 - 9:00 Hugo Latourelle-Vigeant (McGill University), *Matrix Dyson Equation for Correlated Linearizations*, RanMatT (p. 177), Imagination

8:30 - 9:00 Miroslav Lovric (McMaster), *Why numeracy should have a life of its own*, SupNum (p. 173), Grand Salon Opera A

8:30 - 9:00 Xin Yang Lu (Lakehead University), *A physicality-enforcing convex singular potential*, GeoCalc (p. 120), Symphonie 7

8:30 - 9:00 Neal Madras (York University), *Must random walk move rapidly on either a graph or its complement?*, AlgGrTh (p. 56), Symphonie 4B

8:30 - 9:00 Javad Mashreghi (Université Laval), *A Banach–Steinhaus type theorem*, HarmPDE (p. 124), Ovation

8:30 - 9:00 Lucia Moura (Ottawa), *Cover-free families on hypergraphs*, ComDe (p. 80), Soprano C

8:30 - 9:00 Dinushi Munasinghe (Toronto), *Schur Algebras in Type B*, CluAlgR (p. 75), Inspiration Room

8:30 - 9:00 Bouchra Nasri (Université de Montréal), *Mathematical modeling of mpox: a scoping review*, MSAIMod (p. 136), UQAM - PK-3205

8:30 - 9:00 David Nguyen (Queens University), *Shifted convolutions and applications*, NumTheo (p. 156), Grand Salon Opera B

8:30 - 9:00 Rehana Patel (Wesleyan University & African Institute for Mathematical Sciences, Senegal), DeSetTh (p. 101), Symphonie 1

8:30 - 9:00 Vijay Subramanian (University of Michigan), *Bayesian Learning of Optimal Policies in Markov Decision Processes with Countably Infinite State-Space*, StochCo (p. 166), UQAM - PK-1320

8:30 - 9:00 Wei Sun (Concordia), *Periodic solutions of some SDEs and SPDEs*, MMSPDE (p. 150), UQAM - PK-2605

8:30 - 9:00 Michael Tait (Villanova University), *Counting subgraphs using graph eigenvalues*, AdvMatT (p. 52), Creation

8:30 - 9:00	Jeremie Turcotte (McGill University), *On an induced version of Menger's theorem*, MatGrCo (p. 99)
8:50 - 9:30	Edward Chernysh (McGill University), *A Struwe-Type Decomposition for Weighted p-Laplace equations of the Caffarelli-Kohn-Nirenberg Type*, GeomAn (p. 106), Symphonie 4A
9:00 - 9:30	Kieran Bhaskara (McMaster University), *Regularity and projective dimension of toric ideals of bipartite graphs*, CommAlg (p. 84), Maestro
9:00 - 9:30	Kelvin Chan (York University), *A cocharge folklore and super coinvariant spaces*, AlgEnCo (p. 61), Symphonie 3B
9:00 - 9:30	Elden Elmanto (University of Toronto), *L-functions and algebraic K-theory*, HomThe (p. 130), Symphonie 3A
9:00 - 9:30	Julien Keller (UQAM), *Variational and non-archimedean aspects of the correspondence for vector bundles*, AlgAriG (p. 66), Symphonie 2B
9:00 - 9:30	Justin Ko (University of Waterloo), *Spectral Phase Transitions in Non-Linear Wigner Spiked Models*, RanMatT (p. 177), Imagination
9:00 - 9:30	Brayden Letwin (University of Alberta, Canada), *On a generalization of Grünbaum's inequality*, GeoFunA (p. 112)
9:00 - 9:30	Shuxing Li (Delaware), *Balanced Splittable Hadamard Matrices: Constraints and Constructions*, ComDe (p. 80), Soprano C
9:00 - 9:30	Roland Malhame (University of Montreal), *A bottom-up approach to the construction of socially optimal discrete choices under congestion*, StochCo (p. 164), UQAM - PK-1320
9:00 - 9:30	Soheil Memariansorkhabi (University of Toronto), *Growth Rate of Rational Points on Non-Compact Complex Ball Quotients*, NumTheo (p. 156), Grand Salon Opera B
9:00 - 9:30	Hermie Monterde (University of Manitoba), *Hadamard diagonalizability and generalizations*, AdvMatT (p. 51), Creation
9:00 - 9:30	Joy Morris (University of Lethbridge), *Can we detect (Di)Graphical Regular Representations easily ?*, MatGrCo (p. 97)
9:00 - 9:30	Iain Moyles (York), *Bifurcations in fear behaviour impact final-size in a disease epidemic*, MSAIMod (p. 136), UQAM - PK-3205
9:00 - 9:30	Yana Nec (Thompson Rivers), *Weak solutions to diffusion equation with piecewise constant diffusivity*, MMSPDE (p. 149), UQAM - PK-2605
9:00 - 9:30	Alain Didier Noutchegueme (UDM), *Shape Optimisation for Steklov transmission eigenvalues on surfaces*, ComGSpe (p. 91)
9:00 - 9:30	Elina Robeva (University of British Columbia), *Learning Causal Models via Algebraic Constraints*, MaMach (p. 144), Soprano A
9:00 - 9:30	Lorena Aguirre Salazar (Lakehead University), *On a relationship between the TFDW and the Liquid Drop models via Gamma convergence*, GeoCalc (p. 120), Symphonie 7
9:00 - 9:30	Iian Smythe (University of Winnipeg), *A descriptive approach to manifold classification*, DeSetTh (p. 101), Symphonie 1
9:00 - 9:30	Mariia Sobchuk (University of Waterloo), *Quantum isomorphisms*, AlgGrTh (p. 57), Symphonie 4B
9:00 - 9:30	Bruno Staffa (University of Toronto), *Generic density of geodesic nets*, GeoPDE (p. 118), Symphonie 2A
9:00 - 9:30	James Steele (Calgary), *Koszul duality phenomenon in the p-adic local Langlands*, AutoRep (p. 72), UQAM - PK-2205
9:00 - 9:30	Gordana Todorov (Northeastern), *Higher Auslander Algebras and Fundamental Domains of Cluster Categories*, CluAlgR (p. 75), Inspiration Room
9:00 - 9:30	Nahid Walji (University of British Columbia), *Mathematics and Numeracy for Liberal Arts Students*, SupNum (p. 174), Grand Salon Opera A
9:00 - 9:30	Mahishanka Withanachchi (Université Laval), *Polynomial Approximation in Local Dirichlet Spaces*, HarmPDE (p. 126), Ovation
9:30 - 10:00	Houari Benammar Ammar (UQAM), *Slope inequality for an arbitrary divisor.*, AlgAriG (p. 64), Symphonie 2B
9:30 - 10:00	Kristine Bauer (University of Calgary), *Faa di Bruno for bicategories*, HomThe (p. 129), Symphonie 3A
9:30 - 10:00	Ludovick Bouthat (Université Laval), *The Geometry of the Birkhoff Polytope*, AdvMatT (p. 48), Creation
9:30 - 10:00	Ziteng Cheng (University of Toronto), *Mean field regret in discrete time games*, StochCo (p. 162), UQAM - PK-1320

9:30 - 10:00	Elizabeth Collins-Woodfin (McGill), *High dimensional limit of streaming SGD for generalized linear models*, MaMach (p. 142), Soprano A
9:30 - 10:00	Akashdeep Dey (University of Toronto), *Existence of closed geodesics on certain non-compact Riemannian manifolds*, GeoPDE (p. 117), Symphonie 2A
9:30 - 10:00	Lucas Gagnon (York University), *The shadows of quasisymmetric Templerley—Lieb coinvariants are non-crossing partitions*, AlgEnCo (p. 62), Symphonie 3B
9:30 - 10:00	Jonathan Husson (University of Michigan), *Generalized empirical covariance matrices and large deviations.*, RanMatT (p. 176), Imagination
9:30 - 10:00	Dima Jakobson (McGill), *Nodal sets and negative eigenvalues in conformal geometry*, ComGSpe (p. 90)
9:30 - 10:00	Nathan Johnston (Mount Allison University), *Laplacian* $\{-1,0,1\}$*- and* $\{-1,1\}$*-diagonalizable graphs*, MatGrCo (p. 96)
9:30 - 10:00	Caleb Jones (MUN), *Burning Steiner Triple Systems*, ComDe (p. 79), Soprano C
9:30 - 10:00	Adilbek Kairzhan (Toronto), *A Hamiltonian Dysthe equation for deep-water gravity waves with constant vorticity*, MMSPDE (p. 147), UQAM - PK-2605
9:30 - 10:00	Sooyeong Kim (York University), *Kemeny's constant and enumerating Braess edges in trees*, AlgGrTh (p. 55), Symphonie 4B
9:30 - 10:00	Iresha Madduwe (Dalhousie University), *Reconstruction Conjecture on Homological Invariants of Cameron Walker Graphs*, CommAlg (p. 86), Maestro
9:30 - 10:00	Asia Matthews, *Combining Numeracy and Rhetoric in an Interdisciplinary Modelling Course*, SupNum (p. 173), Grand Salon Opera A
9:30 - 10:00	Antoine Poulin (McGill University), *Space of Archimedean Left-Orders*, DeSetTh (p. 101), Symphonie 1
9:30 - 10:00	Eli Putterman (TAU, Israel), *Small-ball probabilities for mean widths of random polytopes*, GeoFunA (p. 113)
9:30 - 10:00	Mishty Ray (University of Calgary), *Introduction to geometry of local Arthur packets*, NumTheo (p. 157), Grand Salon Opera B
9:30 - 10:00	Jhoana P. Romero-Leiton (University of Manitoba), *Mathematical modelling of the first HIV/ZIKV co-infection cases in Colombia and Brazil*, MSAIMod (p. 136), UQAM - PK-3205
9:30 - 10:00	Hugh Thomas (UQAM), *Generalized associahedra as moment polytopes*, CluAlgR (p. 75), Inspiration Room
9:30 - 10:00	Jack Tisdell (McGill University), *Minimizing asymptotic score in random bullseye darts for i.i.d. throws*, GeoCalc (p. 121), Symphonie 7
9:30 - 10:00	Ekta Tiwari (Ottawa), *Irreducible supercuspidals of unramified* $U(1,1)$, AutoRep (p. 72), UQAM - PK-2205
9:30 - 10:00	Junjie Zhu (University of British Columbia), *Cones are not Salem*, HarmPDE (p. 127), Ovation
9:40 - 10:20	Fang Hong (McGill University), *Sharpened Minkowski Inequality in Cartan-Hadamard Spaces*, GeomAn (p. 107), Symphonie 4A
10:00 - 10:30	Farid Aliniaeifard (UBC), *Generalized chromatic functions*, AlgEnCo (p. 60), Symphonie 3B
10:00 - 10:30	Patrick Allen (McGill), *Minimal R = T in the absence of minimal lifts*, AutoRep (p. 69), UQAM - PK-2205
10:00 - 10:30	Rachael Alvir (University of Waterloo), *Scott Complexity*, DeSetTh (p. 100), Symphonie 1
10:00 - 10:30	Ada Chan (York University), *Quantum isomorphism and Hadamard graphs*, MatGrCo (p. 95)
10:00 - 10:30	Peter Danziger (TMU), *Colouring Kirkman triple systems*, ComDe (p. 79), Soprano C
10:00 - 10:30	Julian Haddad (University of Sevilla, Spain), *Fiber symmetrization and the Rogers-Brascamp-Lieb-Luttinger inequality*, GeoFunA (p. 111)
10:00 - 10:30	Joel Kamnitzer (McGill University), *Moduli space of cactus flower curves*, AlgAriG (p. 66), Symphonie 2B
10:00 - 10:30	Paula Kimmerling (Washington State University), *Continuous-Time Quantum Walks on Windmill Graphs*, AlgGrTh (p. 55), Symphonie 4B
10:00 - 10:30	Alexis Leroux Lapierre (McGill), *An algebraic equivariant multiplicity using limits of characters*, CluAlgR (p. 74), Inspiration Room
10:00 - 10:30	Peilin Li (University of British Columbia), *Building Monomial Ideal with Fixed Betti Number*, CommAlg (p. 86), Maestro
10:00 - 10:30	Frédéric Morneau-Guérin (Université TÉLUQ), *The diameter of the Birkhoff polytope*, AdvMatT (p. 51), Creation
10:00 - 10:30	Anton Mosunov and Gavin Orok (University of Waterloo), *Assessing the Effect of an Illustrated Storybook on Correcting Common Misconceptions About Mathematics*, SupNum (p. 174), Grand Salon Opera A

10:00 - 10:30	Tristan Ozuch (MIT), *Selfduality along Ricci flow and instabilities of Einstein metrics*, GeoPDE (p. 118), Symphonie 2A
10:00 - 10:30	Vincent Painchaud (McGill University), *Convergence of the stochastic Airy operator to the stochastic sine operator*, RanMatT (p. 178), Imagination
10:00 - 10:30	Dorette Pronk (Dalhousie University), *Double Category Sites for Grothendieck Topoi*, HomThe (p. 132), Symphonie 3A
10:00 - 10:30	Matthew Scott (McGill University), *When are generative models suitable for signal recovery from subsampled Fourier measurements ?*, MaMach (p. 145), Soprano A
10:00 - 10:30	Leonid Slavin (University of Cincinnati), *Monotone rearrangement and Bellman functions for VMO with generalized Campanato norm*, HarmPDE (p. 126), Ovation
10:00 - 10:30	Ihsan Topaloglu (Virginia Commonwealth University), *Minimizing sets of weakly-repulsive nonlocal energies*, GeoCalc (p. 121), Symphonie 7
10:00 - 10:30	Woldegebriel Assefa Woldegerima (York), *Quantifying the Basic Reproduction Number and the Underestimated Fraction of Mpox Cases: Mathematical Modelling and ML Study*, MSAIMod (p. 137), UQAM - PK-3205
10:00 - 10:30	Chi Hoi (Kyle) Yip (Kyle) Yip (University of British Columbia), *Additive decompositions of multiplicative subgroups*, NumTheo (p. 157), Grand Salon Opera B
10:00 - 10:30	Bora Yongacoglu (University of Toronto), *Connections between POMDPs and partially observed n-player mean-field games*, StochCo (p. 166), UQAM - PK-1320
10:00 - 10:30	Xiaowen Zhou (Concordia), *Speed of explosion for continuous-state branching processes with nonlinear branching mechanism*, MMSPDE (p. 151), UQAM - PK-2605
10:30 - 11:00	Break / Pause, Activ, Grand Salon Opera Foyer
11:00 - 11:30	Jean-Marie De Koninck (Université Laval), *The human part of the equation*, EdPlen (p. 41), Grand Salon Opera AB
13:30 - 14:30	Dr. Robert Haslhofer (University of Toronto), *Mean curvature flow through singularities*, Prize (p. 43), Grand Salon Opera AB
14:30 - 15:00	Break / Pause, Activ, Grand Salon Opera Foyer
15:00 - 15:30	Stéphanie Abo (Waterloo), *Sex-specific mathematical models of energy metabolism during exercise*, SRS (p. 168), Symphonie 2B
15:00 - 15:30	Jacques Bélair (Université de Montréal), *Modeling Variable Compliance to Recommended Interventions to Control Outbreaks*, MSAIMod (p. 135), UQAM - PK-3205
15:00 - 15:30	Andrea Burgess (UNB), *Equitable colourings of cycle systems*, ComDe (p. 78), Soprano C
15:00 - 15:30	Ed Doolittle (First Nations University of Canada), *Numeracy for Indigenous Teacher Candidates*, SupNum (p. 172), Grand Salon Opera A
15:00 - 15:30	Mathilde Gerbelli-Gauthier (McGill University), *An average Sato-Tate for non-tempered representations.*, NumTheo (p. 154), Grand Salon Opera B
15:00 - 15:30	Chris Godsil (University of Waterloo), *Coefficient Matrices*, AlgGrTh (p. 55), Symphonie 4B
15:00 - 15:30	Gena Hahn (Université de Montréal), *Siblings, twins and self-embedded graphs*, MatGrCo (p. 95)
15:00 - 15:30	Avleen Kaur (University of British Columbia), *Unravelling the Friedrichs Angle: A Key to Lower Bounds on the Minimum Singular Value*, AdvMatT (p. 50), Creation
15:00 - 15:30	Mokshay Madiman (University of Delaware, USA), *Submodularity questions in convex geometry*, GeoFunA (p. 113)
15:00 - 15:30	GaYee Park (UQAM), *Generalized parking function*, AlgEnCo (p. 62), Symphonie 3B
15:00 - 15:30	Frédéric Rochon (UQAM), *Torsion on some fibered cusp manifolds*, ComGSpe (p. 91)
15:00 - 15:30	Nick Rozenblyum (University of Toronto), *Stratifications and reflection*, HomThe (p. 133), Symphonie 3A
15:00 - 15:30	Reihaneh Vafadar (Laval), *Weak well-posedness of SDEs with divergence-free drifts*, MMSPDE (p. 150), UQAM - PK-2605
15:00 - 16:00	Eric Sawyer (McMaster University), *A Proof of the Fourier Restriction Conjecture*, HarmPDE (p. 126), Ovation
15:30 - 16:00	Jeremy Chizewer (Waterloo), *Enumeration and Compact Encoding of AVL Trees*, AlgEnCo (p. 61), Symphonie 3B
15:30 - 16:00	Adriana-Stefania Ciupeanu (Manitoba), *Dynamics of Variants of Concern*, SRS (p. 168), Symphonie 2B

15:30 - 16:00 Qing Han (York), MSAIMod (p. 136), UQAM - PK-3205

15:30 - 16:00 Erik Holmes (University of Toronto), *Shapes and asymptotics in number theory*, NumTheo (p. 155), Grand Salon Opera B

15:30 - 16:00 Andrea Hyde (College of the Rockies), *Numeracy in Pre-Ed Students in Rural BC*, SupNum (p. 173), Grand Salon Opera A

15:30 - 16:00 Manuel Lafond (Universite de Sherbrooke), MatGrCo (p. 96)

15:30 - 16:00 Dylan Langharst (Institut Math Jessieu, France), *On the measures satisfying a monotonicity of the surface area with respect to Minkowski sum*, GeoFunA (p. 112)

15:30 - 16:00 Kate Nimegeers (Victoria), *Pseudoku: A Sudoku Adjacency Algebra and Fractional Completion Threshold*, ComDe (p. 81), Soprano C

15:30 - 16:00 Maria Ntekoume (Concordia), *Symplectic non-squeezing for integrable PDEs: the KdV equation on the line*, MMSPDE (p. 149), UQAM - PK-2605

15:30 - 16:00 Tseleung Larry So (University of Western Ontario), *The cohomology of 4-dimensional toric orbifolds*, HomThe (p. 133), Symphonie 3A

15:30 - 16:00 Vukašin Stojisavljević (Université de Montréal), *Nodal topology and persistence barcodes*, ComGSpe (p. 92)

15:30 - 16:00 Heather Switzer (William and Mary), *Exploring the Advantages of Using Sketched Krylov Methods in PRIMME*, AdvMatT (p. 52), Creation

15:30 - 16:00 Christopher van Bommel (University of Guelph), *Fidelities and Readout Times of Quantum State Transfer*, AlgGrTh (p. 57), Symphonie 4B

16:00 - 16:30 Dmitry Faifman (Tel Aviv University, Israel), *Some Whitney extension problems in valuation theory*, GeoFunA (p. 111)

16:00 - 16:30 Viktor Freiman (University of Moncton), *New Brunswick path to numeracy in technology-rich environments: what elementary school teachers should be aware of ?*, SupNum (p. 172), Grand Salon Opera A

16:00 - 16:30 Sam Hopkins (Howard University), *Combinatorial reciprocity for non-intersecting paths*, AlgEnCo (p. 62), Symphonie 3B

16:00 - 16:30 Marti Roset Julià (McGill University), *The Gross–Kohnen–Zagier theorem via p-adic uniformization*, NumTheo (p. 155), Grand Salon Opera B

16:00 - 16:30 Jude Kong (York), MSAIMod (p. 136), UQAM - PK-3205

16:00 - 16:30 Nahid Sadr (Sherbrooke), *Index-mixed copulas*, SRS (p. 170), Symphonie 2B

16:00 - 16:30 Mahsa N. Shirazi (University of Manitoba), *Uniform hypergraphs and balanced incomplete block designs with r-friendship property*, MatGrCo (p. 98)

16:00 - 16:30 Doug Stinson (Waterloo), *Circular external difference families, graceful labellings and cyclotomy*, ComDe (p. 82), Soprano C

16:00 - 16:30 Ian Thompson (University of Manitoba), *Peaking phenomena in finite-dimensions*, AdvMatT (p. 52), Creation

16:00 - 16:30 Ignacio Uriarte-Tuero (University of Toronto), *Some remarks on Muckenhoupt Ap weights*, HarmPDE (p. 126), Ovation

16:00 - 16:30 Luc Vinet (Université de Montréal), *m-distance regular graphs and multivariate P-polynomial association schemes*, AlgGrTh (p. 57), Symphonie 4B

16:00 - 16:30 Denis Vinokurov (Université de Montréal), *The first eigenvalue of the Laplacian on orientable surfaces*, ComGSpe (p. 93)

16:30 - 17:00 Amin Bahmanian (Illinois State), *Toward a Three-dimensional Counterpart of Cruse's Theorem*, ComDe (p. 78), Soprano C

16:30 - 17:00 Alexander Kroitor (Waterloo), SRS (p. 169), Symphonie 2B

16:30 - 17:00 Mohammadreza Mohajer (University of Ottawa), *P-adic periods and p-adic subgroup theorem for 1-motives*, NumTheo (p. 156), Grand Salon Opera B

16:30 - 17:00 Michael Penrod (University of Alabama), *Convolution Operators on Matrix Weighted Variable Lebesgue Spaces*, HarmPDE (p. 125), Ovation

16:30 - 17:00 Shivaram Pragada (Simon Fraser University), *Subdivision and Adjacency spectra of Graphs*, MatGrCo (p. 98)

16:30 - 17:00 Idriss Sekkak (Université de Montréal), *An analysis of a Multigroup mpox epidemic model incorporating public health measures*, MSAIMod (p. 137), UQAM - PK-3205

16:30 - 17:00	Yujia Shi (Northeastern University), *Quantifying Transfer Strength on Graphs with Finite Cospectrality*, AlgGrTh (p. 56), Symphonie 4B
16:30 - 17:00	Zhen Shuang (Memorial University), *Fractional p-Laplacian and Signal Decomposition*, GeoFunA (p. 113)
16:30 - 17:00	Paul Skoufranis (York University), *Matrix Majorization in Non-Commutative Contexts*, AdvMatT (p. 51), Creation
16:30 - 17:00	Christine Suurtamm (University of Ottawa), *Equity and Mathematics Teaching and Learning*, SupNum (p. 174), Grand Salon Opera A
16:30 - 17:00	John Toth (McGill), *Goodness estimates in microlocally allowable regions*, ComGSpe (p. 92)
16:30 - 17:00	Jerry Wei (University of Toronto), *Analogies of Lie Group Concepts in S^7 and the Space of Commuting Pairs*, HomThe (p. 134), Symphonie 3A
16:30 - 17:00	Karen Yeats (Waterloo), *Combinatorial interpretation of the coefficients of the BDG action*, AlgEnCo (p. 63), Symphonie 3B
17:00 - 17:30	Dave Anderson (Ohio State University), *New formulas for Schubert polynomials via bumpless pipe dreams*, AlgEnCo (p. 60), Symphonie 3B
17:00 - 17:30	Abhishek Bharadwaj (Queen's University), *On primitivity and vanishing of Dirichlet series*, NumTheo (p. 153), Grand Salon Opera B
17:00 - 17:30	Amanda Chafee (Carleton), *Conditions for a Block Intersection Graph (BIG) of Packings and Coverings to be Hamiltonian & their Relationship to DCCD*, ComDe (p. 78), Soprano C
17:00 - 17:30	Jocelyn Chi (Rice University), *Revisiting Symmetric Tensor Decompositions*, AdvMatT (p. 49), Creation
17:00 - 17:30	Joshua Flynn (Mcgill University, Canada), *The Isoperimetric Problem and Related Mean Curvature Type Flows*, GeoFunA (p. 111)
17:00 - 17:30	Fok Shuen Leung (University of British Columbia), *Poetry without Grammar*, SupNum (p. 173), Grand Salon Opera A
17:00 - 17:30	Gabor Lippner (Northeastern University), *Instability of transfer strength*, AlgGrTh (p. 56), Symphonie 4B
17:00 - 17:30	Bojan Mohar (Simon Fraser University), *Extremal trees for eigenvalue combinations*, MatGrCo (p. 97)
17:00 - 17:30	Cintia Pacchiano (University of Calgary), *Regularity Results for Double Phase Problems on Metric Measure Spaces*, HarmPDE (p. 125), Ovation
17:00 - 17:30	Don Stanley (University of Regina), *Which graded algebras are the cohomology of a space ?*, HomThe (p. 133), Symphonie 3A
17:00 - 17:30	Scott Wesley (Dalhousie), *Towards an Algebraic and Geometric Theory of Quantum Circuits*, SRS (p. 170), Symphonie 2B
17:30 - 18:00	Shreya Dhar, Chenglu Wang, Grayson Plumpton & River Newman (Toronto, Pennsylvania, Queen's, Yale), *On the Classification of Field Extensions of p-adic Fields*, SRS (p. 169), Symphonie 2B
17:30 - 18:00	Oussama Hamza (University of Western Ontario), *On extensions of number fields with given quadratic algebras and cohomology*, NumTheo (p. 154), Grand Salon Opera B
17:30 - 18:00	Josh Kline (University of Cincinnati), *On regularity of sets of finite fractional perimeter in metric measure spaces*, HarmPDE (p. 124), Ovation
17:30 - 18:00	Open Discussion, SupNum (p. 174), Grand Salon Opera A
17:30 - 18:00	Ben Seamone (Dawson College), *Defective acyclic colourings of planar graphs*, MatGrCo (p. 98)
17:30 - 18:00	Christino Tamon (Clarkson University), *Do quantum walks obey speed limits ?*, AlgGrTh (p. 57), Symphonie 4B
17:30 - 18:00	Prateek Vishwakarma (University of Regina), *Plücker inequalities for weakly separated coordinates in totally nonnegative Grassmannian*, AlgEnCo (p. 63), Symphonie 3B
19:00 - 22:00	Awards Banquet / Banquet de prix, Activ, Inspiration

Monday December 4 — lundi 4 décembre

8:00 - 8:30	Christopher James Lang (Waterloo), *Spherically symmetric hyperbolic monopoles*, SRS (p. 169), Symphonie 2B
8:00 - 8:30	Xiaohong Zhang (Universite de Montreal), *Local uniform mixing*, AlgGrTh (p. 58), Symphonie 4B
8:30 - 9:00	Spencer Backman (Vermont), *Higher Categorical Associahedra*, AlgEnCo (p. 60), Symphonie 3B
8:30 - 9:00	David Feder (University of Calgary), *Two-step perfect quantum state transfer on graphs*, AlgGrTh (p. 54), Symphonie 4B
8:30 - 9:00	Chaabane Rejeb (Sherbrooke), *Quasi-homogeneous solutions to the WDVV equations associated with the genus one Hurwitz-Frobenius manifolds.*, SRS (p. 170), Symphonie 2B
9:00 - 9:30	Fadia Ounissi (Concordia), *On Rogers-Shephard type inequalities for (n-1)-dimensional volumes*, SRS (p. 169), Symphonie 2B
9:00 - 9:30	Aysa Tajeri (York University), *Pretty good state transfer on cycles*, AlgGrTh (p. 57), Symphonie 4B
9:00 - 9:30	Gabe Udell (Cornell), *Degenerating brick manifolds and subdividing the associahedron*, AlgEnCo (p. 63), Symphonie 3B
9:30 - 10:00	Jose Bastidas (UQAM), *Alcoved signed permutations*, AlgEnCo (p. 60), Symphonie 3B
9:30 - 10:00	Mark Kempton (Brigham Young University), *Non-backtracking random walks: mixing rate, Kemeny's constant, and related parameters*, AlgGrTh (p. 55), Symphonie 4B
9:30 - 10:00	Haggai Liu (SFU), *Moduli Spaces of Weighted Stable Curves and their Fundamental Groups*, SRS (p. 169), Symphonie 2B
10:00 - 10:30	Marie Albenque (IRIF, Université Paris Cité), *Bijective proof of rational enumerative schemes for maps on the torus of genus g.*, AlgEnCo (p. 59), Symphonie 3B
10:00 - 10:30	Adam Knudson (Brigham Young University), *A Nordhauss-Gaddum type problem for the normalized Laplacian spectrum and graph Cheeger constant*, AlgGrTh (p. 56), Symphonie 4B
10:00 - 10:30	Tonatiuh Matos Wiederhold (Toronto), *The lattice of uniform topologies*, SRS (p. 171), Symphonie 2B
10:30 - 11:00	Break / Pause, Activ, Grand Salon Opera Foyer
11:00 - 12:00	Vincent Bouchard (University of Alberta), *Airy structures: a new connection between geometry, algebra and physics*, Plenary (p. 42), Grand Salon Opera AB
13:30 - 14:30	Dr. Toni Annala (Institute for Advanced Study, Princeton), *Cohomology of Algebraic Varieties*, Prize (p. 43), Grand Salon Opera AB
14:30 - 15:00	Break / Pause, Activ, Grand Salon Opera Foyer
15:30 - 16:00	Sarah Brauner (UQAM), *Card shuffling, derangements, and q-analogues*, AlgEnCo (p. 61), Symphonie 3B
16:00 - 16:30	Jonathan Boretsky (Harvard), *The Totally Nonnegative Tropical Flag Variety*, AlgEnCo (p. 61), Symphonie 3B
16:30 - 17:00	Franco Saliola (UQAM), *Left Regular Bands of Groups and the Mantaci-Reutenauer Algebra*, AlgEnCo (p. 62), Symphonie 3B

Talk List

A

B

Talk List

C

Talk List

D

E

F

G

H

I

J

K

Talk List

L

Talk List

M

Talk List

Madou, Raphael, *Strong solutions on SDEs with singular (form-bounded) drifts via Rockner-Zhao approach.*, MMSPDE (p. 148), Saturday December 2, 9:00 - 9:30, UQAM - PK-2605

Madras, Neal, *Must random walk move rapidly on either a graph or its complement ?*, AlgGrTh (p. 56), Sunday December 3, 8:30 - 9:00, Symphonie 4B

Mahmood, Hasan, *Mutation of Simplicial Complexes*, CommAlg (p. 87), Saturday December 2, 15:00 - 15:30, Maestro

Malhame, Roland, *A bottom-up approach to the construction of socially optimal discrete choices under congestion*, StochCo (p. 164), Sunday December 3, 9:00 - 9:30, UQAM - PK-1320

Mansouri, Farnam, MatGrCo (p. 96), Saturday December 2, 17:30 - 18:00

Martin, Bill, *Delsarte designs in finite groups*, ComDe (p. 80), Saturday December 2, 8:30 - 9:00, Soprano C

Martin, William, *Four-class Q-bipartite association schemes*, MatGrCo (p. 96), Saturday December 2, 15:30 - 16:00

Mashreghi, Javad, *A Banach–Steinhaus type theorem*, HarmPDE (p. 124), Sunday December 3, 8:30 - 9:00, Ovation

Matthews, Asia, *Combining Numeracy and Rhetoric in an Interdisciplinary Modelling Course*, SupNum (p. 173), Sunday December 3, 9:30 - 10:00, Grand Salon Opera A

Mavinkurve, Udit, *The Fundamental Group(oid) in Discrete Homotopy Theory*, HomThe (p. 131), Saturday December 2, 9:00 - 9:30, Symphonie 3A

McCleerey, Nicholas, *Singularities of m-subharmonic Functions*, GeoPDE (p. 117), Saturday December 2, 17:00 - 17:30, Symphonie 2A

Meet, Networking & Greet, SupNum (p. 174), Sunday December 3, 8:00 - 8:30, Grand Salon Opera A

Meger, Erin, *The Spectral Gap of Iterative Complex Networks*, AdvMatT (p. 51), Saturday December 2, 10:00 - 10:30, Creation

Mei, Ming, *Threshold convergence results for nonlocal time-delayed diffusion equations*, WavePh (p. 182), Saturday December 2, 8:30 - 9:00, UQAM - PK-7210

Memariansorkhabi, Soheil, *Growth Rate of Rational Points on Non-Compact Complex Ball Quotients*, NumTheo (p. 156), Sunday December 3, 9:00 - 9:30, Grand Salon Opera B

Meszaros, Andras, *Eigenvectors of the square grid plus GUE*, RanMatT (p. 178), Saturday December 2, 16:00 - 16:30, Imagination

Mezo, Paul, *Arthur packets for real unitary groups*, AutoRep (p. 71), Saturday December 2, 10:00 - 10:30, UQAM - PK-2205

Mignacca, Marco, *Motion Detection Using Dynamic Mode Decomposition*, Poster (p. 186)

Milic, Luka, *Investment Strategies in the Face of Climate Uncertainty: Balancing Transition and Physical Risks*, FunAnTo (p. 104), Saturday December 2, 9:00 - 9:30, UQAM - SH - 3260

Miller, John, *Persistence and Triangulated Categories*, HomThe (p. 132), Saturday December 2, 8:30 - 9:00, Symphonie 3A

Mingo, James, *Infinitesimal Operators*, RanMatT (p. 178), Saturday December 2, 9:00 - 9:30, Imagination

Mohajer, Mohammadreza, *P-adic periods and p-adic subgroup theorem for 1-motives*, NumTheo (p. 156), Sunday December 3, 16:30 - 17:00, Grand Salon Opera B

Mohammad-Teheri, Sina, *Greedy deep unfolding: New neural networks based on sparse recovery algorithms*, Poster (p. 186)

Mohar, Bojan, *Extremal trees for eigenvalue combinations*, MatGrCo (p. 97), Sunday December 3, 17:00 - 17:30

Mojallal, Ahmad, *Forts, (fractional) zero forcing, and Cartesian products of graphs*, MatGrCo (p. 97), Saturday December 2, 10:00 - 10:30

Monson, Hayley & Spencer Locke, *The Saturn Ring Defect for Two Colloidal Particles*, Poster (p. 185)

Monterde, Hermie, *Quantum walks on join graphs*, MatGrCo (p. 97), Saturday December 2, 15:00 - 15:30

Monterde, Hermie, *Hadamard diagonalizability and generalizations*, AdvMatT (p. 51), Sunday December 3, 9:00 - 9:30, Creation

Moore, Kenneth, *Minimal reflective and folding symmetry of convex sets*, GeoFunA (p. 113), Saturday December 2, 16:30 - 17:00

Moresco, Marlon, *Uncertainty Propagation and Dynamic Robust Risk Measures*, FunAnTo (p. 104), Saturday December 2, 16:30 - 17:00, UQAM - SH - 3260

Morneau-Guérin, Frédéric, *The diameter of the Birkhoff polytope*, AdvMatT (p. 51), Sunday December 3, 10:00 - 10:30, Creation

Morrill, Rachel Hardeman, *Path Categories and Graphs*, HomThe (p. 132), Saturday December 2, 9:30 - 10:00, Symphonie 3A

Morris, Joy, *Can we detect (Di)Graphical Regular Representations easily ?*, MatGrCo (p. 97), Sunday December 3, 9:00 - 9:30

Morrow, Michael, *Syzygy Computations in OI-Modules*, CommAlg (p. 87), Saturday December 2, 9:30 - 10:00, Maestro

Mosunov, Anton & Gavin Orok, *Assessing the Effect of an Illustrated Storybook on Correcting Common Misconceptions About Mathematics*, SupNum (p. 174), Sunday December 3, 10:00 - 10:30, Grand Salon Opera A

N

O

Talk List

P

Pacchiano, Cintia, *Regularity Results for Double Phase Problems on Metric Measure Spaces*, HarmPDE (p. 125), Sunday December 3, 17:00 - 17:30, Ovation

Painchaud, Vincent, *Convergence of the stochastic Airy operator to the stochastic sine operator*, RanMatT (p. 178), Sunday December 3, 10:00 - 10:30, Imagination

Parez, Gilles, *The range of entanglement*, StatMec (p. 159), Saturday December 2, 10:00 - 10:30, Symphonie 3B

Park, GaYee, *Generalized parking function*, AlgEnCo (p. 62), Sunday December 3, 15:00 - 15:30, Symphonie 3B

Patel, Rehana, DeSetTh (p. 101), Sunday December 3, 8:30 - 9:00, Symphonie 1

Payne, Sam, *Cohomology groups of moduli spaces of curves*, AlgAriG (p. 66), Saturday December 2, 8:00 - 8:30, Symphonie 2B

Peilen, Luke, *Local Laws and Fluctuations for Log Gases*, RanMatT (p. 178), Saturday December 2, 16:30 - 17:00, Imagination

Penrod, Michael, *Convolution Operators on Matrix Weighted Variable Lebesgue Spaces*, HarmPDE (p. 125), Sunday December 3, 16:30 - 17:00, Ovation

Period, Answer & Question, MathPub (p. 139), Saturday December 2, 10:00 - 10:30, UQAM - PK-6605

Period, Answer & Question, MathPub (p. 139), Saturday December 2, 17:00 - 17:30, UQAM - PK-6605

Picard, Sebastien, *Strominger system and complex geometry*, GeomAn (p. 107), Saturday December 2, 8:50 - 9:30, Symphonie 4A

Pinet, Theo, *Inflations for representations of shifted quantum affine algebras*, CluAlgR (p. 75), Saturday December 2, 16:00 - 16:30, Inspiration Room

Plumpton, Grayson, River Newman, Shreya Dhar & Chenglu Wang, *On the Classification of Field Extensions of p-adic Fields*, SRS (p. 169), Sunday December 3, 17:30 - 18:00, Symphonie 2B

Ponasso, Guillermo Nunez, *Maximal determinants of matrices with entries in the roots of unity*, ComDe (p. 81), Saturday December 2, 9:30 - 10:00, Soprano C

Potgieter, Hanna, *Numerical approximation of the first p-Laplace eigenpair for large p values*, ComGSpe (p. 91), Saturday December 2, 15:30 - 16:00

Poulin, Antoine, *Space of Archimedean Left-Orders*, DeSetTh (p. 101), Sunday December 3, 9:30 - 10:00, Symphonie 1

Poulin, Valérie, *Hypergraph exploration via vectorization*, MathPub (p. 139), Saturday December 2, 16:00 - 16:30, UQAM - PK-6605

Pradhan, Somnath, *Existence and Discrete-Time Approximations of Optimal Controls for Controlled Diffusions under General Information Structures*, StochCo (p. 164), Saturday December 2, 8:00 - 8:30, UQAM - PK-1320

Pragada, Shivaram, *Subdivision and Adjacency spectra of Graphs*, MatGrCo (p. 98), Sunday December 3, 16:30 - 17:00

Pronk, Dorette, *Double Category Sites for Grothendieck Topoi*, HomThe (p. 132), Sunday December 3, 10:00 - 10:30, Symphonie 3A

Prudhomme, Serge, *Reduced-order modeling for the wave equation using Green's functions and neural networks*, MaMach (p. 144), Saturday December 2, 16:00 - 16:30, Soprano A

Putterman, Eli, *Small-ball probabilities for mean widths of random polytopes*, GeoFunA (p. 113), Sunday December 3, 9:30 - 10:00

Q

Question & Answer Period, MathPub (p. 139), Saturday December 2, 10:00 - 10:30, UQAM - PK-6605

Question & Answer Period, MathPub (p. 139), Saturday December 2, 17:00 - 17:30, UQAM - PK-6605

R

Ramírez, Elkin, *SYSTEMATIC SEARCH FOR EXTREME BEHAVIOUR IN 3D NAVIER-STOKES EQUATIONS BASED ON THE LADYZHENSKAYA-PRODI-SERRIN CONDITIONS*, MMSPDE (p. 149), Sunday December 3, 8:00 - 8:30, UQAM - PK-2605

Ray, Mishty, *Vogan's conjecture for p-adic GL_n*, AutoRep (p. 71), Saturday December 2, 15:00 - 15:30, UQAM - PK-2205

Ray, Mishty, *Introduction to geometry of local Arthur packets*, NumTheo (p. 157), Sunday December 3, 9:30 - 10:00, Grand Salon Opera B

Raychaudhury, Debaditya, *On the singularities of secant varieties*, AlgAriG (p. 66), Saturday December 2, 9:00 - 9:30, Symphonie 2B

Razafindrasoanaivolala, Arthur Bonkli, *Integers with a sum of co-divisors yielding a square*, JMD (p. 46), Saturday December 2, 16:30 - 17:00, Symphonie 4B

S

Talk List

Selk, Zachary, *Robustness for Near-Brownian Noise via Rough Paths Theory*, StochCo (p. 165), Saturday December 2, 16:00 - 16:30, UQAM - PK-1320

Shapiro, Jacob, *Classification of disordered insulators in 1D*, StatMec (p. 160), Saturday December 2, 17:30 - 18:00, Symphonie 3B

Sher, David, *Bessel function zeroes and Polya's conjecture*, ComGSpe (p. 92), Saturday December 2, 17:00 - 17:30

Shevyakov, Alexey, *New exact plasma equilibria with axial and helical symmetry*, MMSPDE (p. 150), Saturday December 2, 17:00 - 17:30, UQAM - PK-2605

Shi, Yujia, *Quantifying Transfer Strength on Graphs with Finite Cospectrality*, AlgGrTh (p. 56), Sunday December 3, 16:30 - 17:00, Symphonie 4B

Shinko, Forte, *Equivalence relations classifiable by Polish abelian groups*, DeSetTh (p. 101), Saturday December 2, 17:30 - 18:00, Symphonie 1

Shirazi, Mahsa N., *Uniform hypergraphs and balanced incomplete block designs with r-friendship property*, MatGrCo (p. 98), Sunday December 3, 16:00 - 16:30

Shokri, Kianoosh, *Improving upper bounds on the size of some covering arrays of strength 3*, ComDe (p. 82), Saturday December 2, 9:00 - 9:30, Soprano C

Shuang, Zhen, *Fractional p-Laplacian and Signal Decomposition*, GeoFunA (p. 113), Sunday December 3, 16:30 - 17:00

Sigal, Israel Michael, *Some Rigorous Results on Propagation of Quantum Information*, StatMec (p. 160), Saturday December 2, 16:30 - 17:00, Symphonie 3B

Silva, Sergio Da, *Cohen-Macaulay Toric Ideals of Graphs and Geometric Vertex Decomposition*, CommAlg (p. 88), Saturday December 2, 17:00 - 17:30, Maestro

Skoufranis, Paul, *Matrix Majorization in Non-Commutative Contexts*, AdvMatT (p. 51), Sunday December 3, 16:30 - 17:00, Creation

Slavin, Leonid, *Monotone rearrangement and Bellman functions for VMO with generalized Campanato norm*, HarmPDE (p. 126), Sunday December 3, 10:00 - 10:30, Ovation

Smith, Aaron, *Kac's Walk on SO(n) and Related Chains*, RanMatT (p. 179), Saturday December 2, 10:00 - 10:30, Imagination

Smythe, Iian, *A descriptive approach to manifold classification*, DeSetTh (p. 101), Sunday December 3, 9:00 - 9:30, Symphonie 1

So, Tseleung Larry, *The cohomology of 4-dimensional toric orbifolds*, HomThe (p. 133), Sunday December 3, 15:30 - 16:00, Symphonie 3A

Sobchuk, Mariia, *Quantum isomorphisms*, AlgGrTh (p. 57), Sunday December 3, 9:00 - 9:30, Symphonie 4B

Sroka, Marcin, *On the conjecture of Alesker-Verbitsky*, GeoPDE (p. 118), Saturday December 2, 9:00 - 9:30, Symphonie 2A

Staffa, Bruno, *Generic density of geodesic nets*, GeoPDE (p. 118), Sunday December 3, 9:00 - 9:30, Symphonie 2A

Stanley, Don, *Which graded algebras are the cohomology of a space ?*, HomThe (p. 133), Sunday December 3, 17:00 - 17:30, Symphonie 3A

Stantejsky, Dominik, *On Minimizing Harmonic Maps with Planar Boundary Anchoring*, GeoCalc (p. 120), Saturday December 2, 9:00 - 9:30, Symphonie 7

Steele, James, *Koszul duality phenomenon in the p-adic local Langlands*, AutoRep (p. 72), Sunday December 3, 9:00 - 9:30, UQAM - PK-2205

Stevens, Brett, *Classification and enumeration of single change covering designs*, ComDe (p. 82), Saturday December 2, 15:00 - 15:30, Soprano C

Stinson, Doug, *Circular external difference families, graceful labellings and cyclotomy*, ComDe (p. 82), Sunday December 3, 16:00 - 16:30, Soprano C

Stockdale, Cody, *On the $T1$ theorem for compactness of Calderón-Zygmund operators*, HarmPDE (p. 126), Saturday December 2, 17:30 - 18:00, Ovation

Stojisavljević, Vukašin, *Nodal topology and persistence barcodes*, ComGSpe (p. 92), Sunday December 3, 15:30 - 16:00

Subramanian, Vijay, *Bayesian Learning of Optimal Policies in Markov Decision Processes with Countably Infinite State-Space*, StochCo (p. 166), Sunday December 3, 8:30 - 9:00, UQAM - PK-1320

Sui, Eric, *On Intersections of Hyperplanes Formed by n Points in Low-Dimensional Space*, Poster (p. 187)

Sun, Rui, *Measure of Axiality for Convex Figures*, GeoFunA (p. 114), Saturday December 2, 16:00 - 16:30

Sun, Wei, *Periodic solutions of some SDEs and SPDEs*, MMSPDE (p. 150), Sunday December 3, 8:30 - 9:00, UQAM - PK-2605

Sutton, Craig, ComGSpe (p. 92), Saturday December 2, 9:30 - 10:00

T

U

V

W

X

Y

Z

Public Mitacs Lecture
Conférence publique Mitacs

Schedule/Horaire **Room/Salle: Grand Salon Opera AB**

Friday December 1 **vendredi 1er décembre**

17:00 - 18:00 Yoshua Bengio (Université de Montréal, and the Founder and Scientific Director of Mila – Quebec AI Institute), *Mathematical challenges towards safe AI* (p. 40)

Abstract/Résumé

YOSHUA BENGIO, Université de Montréal, and the Founder and Scientific Director of Mila – Quebec AI Institute
[Friday December 1 / vendredi 1er décembre, 17:00 – Grand Salon Opera AB]
Mathematical challenges towards safe AI

Advances in algorithms and computational capabilities of AI systems based on deep learning have been impressive and herald possibly disruptive transformations in coming years and decades, with great potential for both benefits and risks for humanity. The three winners of the Turing award for deep learning (2018) expect that broad human-level capabilities are likely to be achieved within just a few years or decades and industry is investing billions of dollars per month which are likely to accelerate this process. However, we do not yet know how to design provably safe and controllable AI systems, i.e., systems that behave as we intend. This misalignment could threaten democracy, national security and possibly our collective future either due to malicious actors or a loss of control to runaway AIs. Worse, arguments have been made suggesting that the state-of-the-art AI methodology, based on reinforcement learning, would yield less and less safety as computational power increases. This presentation will argue that there may be a way to design AI systems with probabilistic safety guarantees that improve as we increase the computational capabilities of the underlying neural networks. This would rely on efficient and amortized Bayesian inference in learned causal models, designing AI systems inspired by how scientists and mathematicians come up with theories that are compatible with reason and observed evidence.

Education Plenary
Conférence plénière sur l'éducation

Schedule/Horaire **Room/Salle: Grand Salon Opera AB**

Sunday December 3 **dimanche 3 décembre**

11:00 - 11:30 Jean-Marie De Koninck (Université Laval), *The human part of the equation* (p. 41)

Abstract/Résumé

JEAN-MARIE DE KONINCK, Université Laval

[Sunday December 3 / dimanche 3 décembre, 11:00 – Grand Salon Opera AB]

The human part of the equation

Too often, in the name of rigor or simply due to lack of time, we choose not to talk about the human beings behind important developments in mathematical theory or to explain what led them to the theorems they worked on. In doing so, we fail to capture the excitement involved in discovering new mathematical concepts. We also miss an opportunity to reach out to young students who might otherwise have been attracted to math and find pleasure in exploring the fascinating world of mathematical sciences. Investigating the life of mathematicians will often help one understand why they succeeded where others failed. In this presentation, we will examine how math education and math outreach could benefit from a more people-oriented approach. We will also point out various international activities in math education and math outreach which have proved successful.

Plenary Lectures
Conférences plénières

Schedule/Horaire **Room/Salle: Grand Salon Opera AB**

Saturday December 2 — samedi 2 décembre

11:00 - 12:00 Déborah Oliveros (UNAM), *From classical geometry to new constructions of bodies of constant width* (p. 42)

Monday December 4 — lundi 4 décembre

11:00 - 12:00 Vincent Bouchard (University of Alberta), *Airy structures: a new connection between geometry, algebra and physics* (p. 42)

Abstracts/Résumés

VINCENT BOUCHARD, University of Alberta

[Monday December 4 / lundi 4 décembre, 11:00 – Grand Salon Opera AB]

Airy structures: a new connection between geometry, algebra and physics

Modern physics involves beautiful and intricate mathematics, and entirely new mathematical structures often emerge from physical theories. An example of this is the concept of Airy structures, which was first introduced by Kontsevich and Soibelman in 2017 as an algebraic reformulation and extension of the Chekhov-Eynard-Orantin topological recursion. One can also think of Airy structures as a wide generalization of Witten's conjecture ; as such, it provides a fascinating new connection between enumerative geometry, algebra and integrable systems. In this talk I will introduce the concept of Airy structures, mention some recent applications of the theory to enumerative geometry, vertex operator algebras and gauge theories, and discuss potential generalizations and open questions. My hope with this talk is to convey why I believe that the formalism of Airy structures (and topological recursion) should be in the toolbox of all geometers, algebraists and mathematical physicists !

DÉBORAH OLIVEROS, Unidad Juriquilla del Instituto de Matemáticas UNAM

[Saturday December 2 / samedi 2 décembre, 11:00 – Grand Salon Opera AB]

From classical geometry to new constructions of bodies of constant width

Bodies of constant width are geometric objects with incredible properties that have fascinated mathematicians from centuries ; L. Euler for instance, studied them under the name of "orbiforms" from the Latin word circle-shaped curves. Their properties have not only contributed in generating great applications in the areas of engineering, design and art, but have also motivated the development of great mathematics with unimaginable possibilities that have relation with many interesting open questions.

Prize Lectures
Conférence des lauréats

Schedule/Horaire — **Room/Salle: Grand Salon Opera AB**

Saturday December 2 — samedi 2 décembre

13:30 - 14:30 EDWARD DOOLITTLE (First Nations University of Canada) (p. 43)

Sunday December 3 — dimanche 3 décembre

13:30 - 14:30 DR. ROBERT HASLHOFER (University of Toronto), *Mean curvature flow through singularities* (p. 43)

Monday December 4 — lundi 4 décembre

13:30 - 14:30 DR. TONI ANNALA (Institute for Advanced Study, Princeton), *Cohomology of Algebraic Varieties* (p. 43)

Abstract/Résumé

Adrien Pouliot Award
Prix Adrien-Pouliot

EDWARD DOOLITTLE, First Nations University of Canada
[Saturday December 2 / samedi 2 décembre, 13:30 – Grand Salon Opera AB]

Coxeter-James Prize
Prix Coxeter-James

DR. ROBERT HASLHOFER, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 13:30 – Grand Salon Opera AB]
Mean curvature flow through singularities

A family of surfaces moves by mean curvature flow if the velocity at each point is given by the mean curvature vector. Mean curvature flow first arose as a model of evolving interfaces and has been extensively studied over the last 40 years. In this talk, I will give an introduction and overview for a general mathematical audience. To gain some intuition we will first consider the one-dimensional case of evolving curves. We will then discuss Huisken's classical result that the flow of convex surfaces always converges to a round point. On the other hand, if the initial surface is not convex we will see that the flow typically encounters singularities. Getting a hold of these singularities is crucial for most striking applications in geometry, topology and physics. In particular, we will see that flow through conical singularities is highly nonunique, but flow through neck singularities is unique. Finally, I will report on recent work with various collaborators on the classification of noncollapsed singularities in R^4.

Doctoral Prize
Prix de doctorat

Prize Lectures
Conférence des lauréats

DR. TONI ANNALA, Institute for Advanced Study
[Monday December 4 / lundi 4 décembre, 13:30 – Grand Salon Opera AB]
Cohomology of Algebraic Varieties

Various cohomology theories have played a crucial part in the study of algebro-geometric objects since the birth of modern algebraic geometry in 1960s. Unlike in algebraic topology, not all cohomology theories in algebraic geometry are homotopy invariant, complicating the efforts of defining a good "homotopy category" of varieties, which would support all reasonable cohomology theories. For homotopy-invariant cohomology theories, Morel and Voevodsky constructed such a category in late 90s, which they referred to as A^1-homotopy category. Recently, there have been several attempts to define an analogous category that captures non-homotopy-invariant theories as well. We have been pursuing one candidate for such a category in joint work with R. Iwasa and M. Hoyois.

A celebration in honor of Jean-Marie De Koninck's 75th birthday: Elementary and Analytic Number Theory
Théorie élémentaire et analytique des nombres : Une célébration à l'honneur du 75ème anniversaire de Jean-Marie de Koninck

Org: **Nicolas Doyon** and/et **William Verreault** (Université Laval)

This session focuses on the work of Jean-Marie De Koninck and his numerous research contributions in number theory on the occasion of his 75th birthday. The goal is to bring together colleagues, students, and collaborators of Jean-Marie De Koninck to exchange ideas on past work or new directions in elementary and analytic number theory.

Schedule/Horaire **Room/Salle: Symphonie 4B**

Saturday December 2 **samedi 2 décembre**

8:00 - 8:30	William Verreault (University of Toronto), *On the tower factorization of integers* (p. 47)
8:30 - 9:00	Gary Walsh (University of Ottawa), *Powerful Numbers, Elliptic Curves and other Keywords* (p. 47)
9:00 - 9:30	Chi Hoi (Kyle) Yip (University of British Columbia), *Diophantine tuples over integers and finite fields* (p. 45)
9:30 - 10:00	Sun-Kai Leung (Université de Montréal), *Central limit theorems for arithmetic functions in short intervals* (p. 46)
10:00 - 10:30	Omar Kihel (Brock University), *On the index of a number field and some connected open questions* (p. 46)
15:00 - 15:30	Cihan Sabuncu (Université de Montréal), *On the moments of the number of representations as sums of two prime squares* (p. 47)
15:30 - 16:00	Hugo Chapdelaine (Université Laval), *Conditional convergence in the critical strip for lattice zeta functions associated to totally real fields* (p. 45)
16:00 - 16:30	Siva Nair (Université de Montréal), *The Mahler measure of some polynomial families* (p. 46)
16:30 - 17:00	Arthur Bonkli Razafindrasoanaivolala (Université Laval), *Integers with a sum of co-divisors yielding a square* (p. 46)
17:00 - 17:30	Florian Luca (Wits University), *On the index of friability* (p. 46)
17:30 - 18:00	Theophilus Agama (Université Laval), *On the joint work of Jean-Marie De Koninck and Imre Kátai* (p. 45)

Abstracts/Résumés

THEOPHILUS AGAMA, Université Laval
[Saturday December 2 / samedi 2 décembre, 17:30 – Symphonie 4B]
On the joint work of Jean-Marie De Koninck and Imre Kátai

In this talk, I will present highlights of the joint work of Jean-Marie De Koninck and Imre Kátai produced over the past 40 years, putting much emphasis on their contribution to the study of normal numbers.

HUGO CHAPDELAINE, Université Laval
[Saturday December 2 / samedi 2 décembre, 15:30 – Symphonie 4B]
Conditional convergence in the critical strip for lattice zeta functions associated to totally real fields

The goal of this talk is to explain how a miraculous formula of Brion, related to the enumeration of lattice points in integral convex polytopes implies the conditional convergence of certain Dirichlet series $Z(s)$ when the complex parameter s is such that $1-\epsilon < Re(s)$, for ϵ small enough. Note that the order of summation of the series $Z(s)$ is defined in a geometrical way. In order to simplify the presentation we shall focus on the simplest non-trivial case namely when $Z(s)$ is a lattice zeta function associated to a real quadratic field K. In that case one can take $\epsilon = \frac{1}{2}$.

A celebration in honor of Jean-Marie De Koninck's 75th birthday: Elementary and Analytic Number Theory
Théorie élémentaire et analytique des nombres : Une célébration à l'honneur du 75ème anniversaire de Jean-Marie de Koninck

---

CHI HOI, University of British Columbia
[Saturday December 2 / samedi 2 décembre, 9:00 – Symphonie 4B]
Diophantine tuples over integers and finite fields

A set $\{a_1, a_2, \ldots, a_m\}$ of distinct positive integers is a Diophantine m-tuple if the product of any two distinct elements in the set is one less than a square. There is a long history and extensive literature on the study of Diophantine tuples and their generalizations in various settings. In this talk, we focus on the following generalization: for each $n \geq 1$ and $k \geq 2$, we call a set of positive integers a Diophantine tuple with property $D_k(n)$ if the product of any two distinct elements is n less than a k-th power, and we denote $M_k(n)$ be the largest size of a Diophantine tuple with property $D_k(n)$. Using various tools from number theory, we show that there is $k = k(n)$ such that $k, n \to \infty$ and $M_k(n) = o(\log n)$, breaking the $\log n$ barrier. A key ingredient is to study the finite field model of the same problem. Joint work with Seoyoung Kim and Semin Yoo.

OMAR KIHEL, Brock University
[Saturday December 2 / samedi 2 décembre, 10:00 – Symphonie 4B]
On the index of a number field and some connected open questions

Let K be a number field of degree n over $\mathbb{Q}$, and A its ring of integers. Let $I(K) = \gcd\{[A : Z[\alpha]]\}$, where α primitive element of A. Let p a prime and $I_p(K)$, be the $p-$adic valuation of $I(K)$. Determining $I_p(K)$ is still an open problem. In this talk we will report on some progress towards the computation of the prime divisors of $I(K)$ and some other connected questions.

SUN-KAI LEUNG, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 9:30 – Symphonie 4B]
Central limit theorems for arithmetic functions in short intervals

The distribution of arithmetic functions is a central topic in analytic number theory. In this talk, we discuss various central limit theorems for arithmetic functions in short intervals, in which the Fourier duality lies at the heart of the matter.

FLORIAN LUCA, Wits University
[Saturday December 2 / samedi 2 décembre, 17:00 – Symphonie 4B]
On the index of friability

In a collaboration that spans for 20 years, Jean-Marie De Koninck and the speaker have published 26 research papers, co-authored one textbook and co-edited a book on Anatomy of Integers. In my talk, I will survey a few of our joint results. I will also present some work in progress concerning the index of friability of integers.

SIVA NAIR, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 16:00 – Symphonie 4B]
The Mahler measure of some polynomial families

The Mahler measure of a polynomial $P(x_1, x_2, \ldots, x_n)$ is the average value of $\log|P|$ along the unit n-torus $\mathbb{T}^n$ defined by $|x_i| = 1$ for all i. Interest in this quantity arose from the fact that the Mahler measure of certain polynomials is quite remarkable and not just any random real number – they evaluate to special values of L-functions! However, in general, it is very difficult to evaluate Mahler measures of multivariable polynomials. In this talk, we will consider some families of polynomials that contain, for every integer $n > 1$, an n-variable polynomial. We will discuss how the structure of these polynomials lets us compute their Mahler measures as combinations of values of the Riemann zeta function and values of certain Dirichlet L-functions. This talk includes joint work with Matilde Lalín and Subham Roy.

A celebration in honor of Jean-Marie De Koninck's 75th birthday: Elementary and Analytic Number Theory
Théorie élémentaire et analytique des nombres : Une célébration à l'honneur du 75ème anniversaire de Jean-Marie de Koninck

---

ARTHUR BONKLI RAZAFINDRASOANAIVOLALA, Université Laval
[Saturday December 2 / samedi 2 décembre, 16:30 – Symphonie 4B]
Integers with a sum of co-divisors yielding a square

Finding elliptic curves with high ranks has been the focus of much research. Recently, with the goal of generating elliptic curves with a large rank, some authors used large integers n which have many divisors, amongst which one can find divisors d such that $d + n/d$ is a perfect square. This strategy is in itself a motivation for studying the function $\tau_{\square}(n)$ which counts the number of divisors d of an integer n for which $d+n/d$ is a perfect square. We show that $\sum_{n\leq x} \tau_{\square}(n) = c_{\square}x^{3/4} + O(\sqrt{x})$ for some explicit constant $c_{\square}$. Moreover, letting $\rho_1(n) := \max\{d \mid n : d \leq \sqrt{n}\}$ and $\rho_2(n) := \min\{d \mid n : d \geq \sqrt{n}\}$ stand for the middle divisors of n, we show that the order of magnitude of the number of positive integers $n \leq x$ for which $\rho_1(n) + \rho_2(n)$ is a perfect square is $x^{3/4}/\log x$. This is joint work with Jean-Marie De Koninck and Hans Schmidt Ramiliarimanana.

CIHAN SABUNCU, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 4B]
On the moments of the number of representations as sums of two prime squares

The solutions to the system of equations $x_1^2 + x_2^2 = x_3^2 + x_4^2$ with $x_i \leq R$ in integers come in two pairs, the diagonal ones and the off-diagonal ones. The number of off-diagonal solutions is more than that of diagonal solutions. If we instead focus our attention to the case x_i are prime, then the diagonal solutions overtake the off-diagonal solutions; this effect is called "paucity". This phenomenon also continues in the case of the system of three equations. For more equations, we expect off-diagonal solutions to be the main contribution.
In this talk, we will give ideas on how to get an upper bound for the off-diagonal solutions in the two equations case. The approach we present is generalizable to many equations. If time permits, we will also see how to get lower bounds conditional on some quadratic extension of the Green-Tao theorem.

WILLIAM VERREAULT, University of Toronto
[Saturday December 2 / samedi 2 décembre, 8:00 – Symphonie 4B]
On the tower factorization of integers

I will report on recent (and fun !) joint work with Jean-Marie De Koninck on the factorization of integers into towers of primes.

Writing an integer n as a product of prime powers p^a, then factoring each exponent a as a product of prime powers q^b, and so on, we obtain the *tower factorization* of n. We then study the *height* of an integer, namely the number of "floors" in its tower factorization. In particular, given a fixed integer $k \geq 1$, we will see a formula for the density of the set of integers with height k.

GARY WALSH, University of Ottawa - Tutte Institute
[Saturday December 2 / samedi 2 décembre, 8:30 – Symphonie 4B]
Powerful Numbers, Elliptic Curves and other Keywords

In a series of papers, Erdos posed numerous problems about powerful numbers, and more generally, k-full numbers. We will discuss two of these problems that can be solved by exploiting the group structure of elliptic curves defined over the rational numbers, the first of which being related to work of J.-M. de Koninck, and the second concerning the existence of quadruples of coprime powerful numbers in arithmetic progression. In particular, our computations suggest that a new example, which involves integers having 110 digits, is the smallest such quadruple. This is joint work with Michael Bennett.

Advancements in Matrix Theory with Applications

Org: Avleen Kaur (University of British Columbia), **Karen Meagher** (University of Regina) and/et **Hermie Monterde** (University of Manitoba)

This session features talks that showcase results in various topics within pure and applied matrix theory, broadly construed. A strength of this session is that many of the speakers work on the applications of techniques from spectral theory, numerical linear algebra and operator theory, both in the real world and in other areas of pure mathematics. One of our goals is to learn how these tools can be adeptly utilized to address intricate challenges spanning diverse fields.

Schedule/Horaire **Room/Salle: Creation**

Saturday December 2 samedi 2 décembre

8:30 - 9:00	Minerva Catral (Xavier University), *Spectral properties of a structured matrix related to a system of second order ODEs* (p. 49)
9:00 - 9:30	Amy Yielding (Eastern Oregon University), *An Investigation of Coefficient Sign Arbitrary Patterns* (p. 52)
9:30 - 10:00	Jane Breen (Ontario Tech University), *A structured condition number for Kemeny's constant* (p. 49)
10:00 - 10:30	Erin Meger (Queen's University), *The Spectral Gap of Iterative Complex Networks* (p. 51)
15:00 - 15:30	Christina Christara (University of Toronto), *Properties of matrices arising from Black-Scholes equations* (p. 49)
15:30 - 16:00	Malena Espanol (Arizona State University), *Variable Projection Methods for Separable Nonlinear Inverse Problems* (p. 50)
16:00 - 16:30	Eric Evert (Northwestern University), *Free extreme points of free spectrahedrops and generalized free spectrahedra* (p. 50)
16:30 - 17:00	Brock Klippenstein (University of Manitoba), *Numerical Solution of Non-Normal Coefficient Sylvester Equations for Partial Differential Equations* (p. 50)
17:00 - 17:30	Xiaohong Zhang (Université de Montreal), *Laplacian cospectral graphs* (p. 53)
17:30 - 18:00	Harmony Zhan (Worcester Polytechnic Institute), *Spectra of line digraphs and their applications* (p. 53)

Sunday December 3 dimanche 3 décembre

8:30 - 9:00	Michael Tait (Villanova University), *Counting subgraphs using graph eigenvalues* (p. 52)
9:00 - 9:30	Hermie Monterde (University of Manitoba), *Hadamard diagonalizability and generalizations* (p. 51)
9:30 - 10:00	Ludovick Bouthat (Université Laval), *The Geometry of the Birkhoff Polytope* (p. 48)
10:00 - 10:30	Frédéric Morneau-Guérin (Université TÉLUQ), *The diameter of the Birkhoff polytope* (p. 51)
15:00 - 15:30	Avleen Kaur (University of British Columbia), *Unravelling the Friedrichs Angle: A Key to Lower Bounds on the Minimum Singular Value* (p. 50)
15:30 - 16:00	Heather Switzer (William and Mary), *Exploring the Advantages of Using Sketched Krylov Methods in PRIMME* (p. 52)
16:00 - 16:30	Ian Thompson (University of Manitoba), *Peaking phenomena in finite-dimensions* (p. 52)
16:30 - 17:00	Paul Skoufranis (York University), *Matrix Majorization in Non-Commutative Contexts* (p. 51)
17:00 - 17:30	Jocelyn Chi (Rice University), *Revisiting Symmetric Tensor Decompositions* (p. 49)

Abstracts/Résumés

LUDOVICK BOUTHAT, Université Laval
[Sunday December 3 / dimanche 3 décembre, 9:30 – Creation]
The Geometry of the Birkhoff Polytope

Advancements in Matrix Theory with Applications

The geometry of the Birkhoff polytope, i.e., the compact convex set of all $n \times n$ doubly stochastic matrices, has been an active subject of research. While its faces, edges and facets as well as its volume have been intensely studied, other geometric characteristics such as the center and radius were left off, despite their natural uses in some areas of mathematics. In this talk, we present recent results on the Chebyshev center and the Chebyshev radius of the Birkhoff polytope associated with the metrics induced by the operator norms from ℓ_n^p to ℓ_n^p and by the Schatten p-norms, both for the range $1 \leq p \leq \infty$. While studying these properties, an intrinsic connection to the minimal trace, which naturally appears in the assignment problem, is also established.

JANE BREEN, Ontario Tech University
[Saturday December 2 / samedi 2 décembre, 9:30 – Creation]
A structured condition number for Kemeny's constant

Kemeny's constant is an interesting and useful quantifier describing the global average behaviour of a Markov chain. In this talk, we will examine the sensitivity of Kemeny's constant to perturbations in the transition probabilities of the Markov chain. That is, we consider the problem of generating a condition number for Kemeny's constant, to give an indication of the size of the change in its value relative to the size of the perturbation. We will motivate this investigation with some interesting applications of Kemeny's constant.

MINERVA CATRAL, Xavier University
[Saturday December 2 / samedi 2 décembre, 8:30 – Creation]
Spectral properties of a structured matrix related to a system of second order ODEs

We consider real matrices of the form $C = \begin{bmatrix} A & B \\ I & O \end{bmatrix}$ where A, B are square matrices and I, O are the identity matrix and zero matrix, respectively. Such matrices arise from dynamical systems of second-order ordinary differential equations $\ddot{\mathbf{x}} = A\dot{\mathbf{x}} + B\mathbf{x}$ where A and B are real matrices of order n. Eigenvalue properties are studied for the sign pattern $\mathcal{C} = \begin{bmatrix} \mathcal{A} & \mathcal{B} \\ \mathcal{D} & O \end{bmatrix}$ of order $2n$, where $\mathcal{A}, \mathcal{B}$ are the sign patterns of A, B respectively, and $\mathcal{D}$ is a positive diagonal sign pattern. This talk gives an overview of results from joint works with Adam Berliner, D.D. Olesky and P. van den Driessche.

JOCELYN CHI, Rice University
[Sunday December 3 / dimanche 3 décembre, 17:00 – Creation]
Revisiting Symmetric Tensor Decompositions

In this work we present a simple method for computing a symmetric CP decomposition based on a Gauss-Newton linearization. The algorithm requires solving a sequence of linear least squares problems. With modest modification our approach can be extended to compute symmetric decompositions under additional constraints such as nonnegativity and sparsity. We present empirical results highlighting the effectiveness of the approach. This is joint work with Eric Chi.

CHRISTINA CHRISTARA, University of Toronto, Depart. of Computer Science
[Saturday December 2 / samedi 2 décembre, 15:00 – Creation]
Properties of matrices arising from Black-Scholes equations

The Black-Scholes equation and various versions of it are used for modelling many financial problems. While the Black-Scholes equation is a parabolic Partial Differential Equation (PDE) and it is often discretized by typical centered finite differences in space and Crank-Nicolson timestepping, it is not as "typical" parabolic PDE, as many would think. In this talk, we discuss some of the peculiarities these parabolic PDE problems exhibit, including positive and negative interest rates, unusual boundary

conditions, special nonuniform grids, vanishing coefficients, etc, and the effect these have on the arising matrices. We also discuss the performance of certain solvers and preconditioners for the arising discrete equations.

MALENA ESPANOL, Arizona State University
[Saturday December 2 / samedi 2 décembre, 15:30 – Creation]
Variable Projection Methods for Separable Nonlinear Inverse Problems

Variable projection methods are among the classical and efficient methods to solve separable nonlinear least squares problems. In this talk, I will introduce the variable projection method to solve large-scale blind deconvolution problems.

ERIC EVERT, Northwestern University
[Saturday December 2 / samedi 2 décembre, 16:00 – Creation]
Free extreme points of free spectrahedrops and generalized free spectrahedra

Matrix convexity generalizes convexity to the dimension free setting and has connections to many mathematical and applied pursuits including operator theory, quantum information, noncommutative optimization, and linear control systems. In the setting of classical convex sets, extreme points are central objects. For example, the well-known Minkowski theorem shows that any element of a closed bounded convex set can be expressed as a convex combination of extreme points. Extreme points are also of great interest in the dimension free setting of matrix convex sets ; however, here the situation requires more nuance, as there are many types of extreme points for matrix convex sets. Of particular interest are free extreme points, a highly restricted type of extreme point that is connected to the dilation theoretic Arveson boundary.

Building on a recent work of J. W. Helton and the speaker which shows that free spectrahedra, i.e., dimension free solution sets to linear matrix inequalities, are spanned by their free extreme points, this talk establishes two additional classes of matrix convex sets that are spanned by their free extreme points. Namely, we show that closed bounded free spectrahedrops, i.e, closed bounded projections of free spectrahedra, are the span of their free extreme points. Furthermore, we show that if one considers linear operator inequalities that have compact operator defining tuples, then the resulting "generalized" free spectrahedra are spanned by their free extreme points.

AVLEEN KAUR, The University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 15:00 – Creation]
Unravelling the Friedrichs Angle: A Key to Lower Bounds on the Minimum Singular Value

Estimating the eigenvalues of a sum of two symmetric matrices, say $P + Q$, in terms of the eigenvalues of P and Q, has a long tradition. To our knowledge, no study has yielded a positive lower bound on the minimum eigenvalue, $\lambda_{\min}(P + Q)$, when $P + Q$ is symmetric positive definite with P and Q singular positive semi-definite. We derive two new lower bounds on $\lambda_{\min}(P+Q)$ in terms of the minimum positive eigenvalues of P and Q. The bounds take into account geometric information by utilizing the Friedrichs angles between certain subspaces. The basic result is when P and Q are two non-zero singular positive semi-definite matrices such that $P+Q$ is non-singular, then $\lambda_{\min}(P+Q) \geq (1-\cos\theta_F)\min\{\lambda_{\min}(P), \lambda_{\min}(Q)\}$, where $\lambda_{\min}$ represents the minimum positive eigenvalue of the matrix, and θ_F is the Friedrichs angle between the range spaces of P and Q. We will discuss the interaction between the range spaces for some pair of small matrices to elucidate the geometric aspect of these bounds. Such estimates lead to new lower bounds on the minimum singular value of full rank 1×2, 2×1, and 2×2 block matrices in terms of the minimum positive singular value of these blocks. Some examples provided in this talk further highlight the simplicity of applying the results in comparison to some existing lower bounds. This is joint work with S. H. Lui (University of Manitoba).

BROCK KLIPPENSTEIN, University of Manitoba
[Saturday December 2 / samedi 2 décembre, 16:30 – Creation]
Numerical Solution of Non-Normal Coefficient Sylvester Equations for Partial Differential Equations

Advancements in Matrix Theory with Applications

A method for solving certain partial differential equations, such as the heat or wave equation, numerically consists of discretizing the equation to obtain a matrix equation known as a *Sylvester equation*. It is well-known that Sylvester equations equations can be solved quickly if among other conditions, certain matrices are normal. In this talk, we will discuss to solve Sylvester equations while trading in the normality condition for a norm condition. The main tool used here is *dilation theory*, where we can view an operator as the top left entry of a bigger operator with nice properties, such as being normal. Additionally, we will look at an example of solving a partial integro-differential equation numerically which results in a Sylvester equation with a non normal coefficient.

This is joint work with Dr. Mikael Slevinsky and Dr. Raphael Clouatre.

ERIN MEGER, Queen's University
[Saturday December 2 / samedi 2 décembre, 10:00 – Creation]
The Spectral Gap of Iterative Complex Networks

Complex Networks appear in applications all around us, from the internet to social networks. These networks exhibit a range of similar properties including large scale, power-law degree distribution, and small-world properties. Studying the *spectral gap* of complex networks reveals an understanding of the underlying community structures. We will explore the spectral gap of iterated models for complex networks. In these models, each subsequent graph is created through a deterministic generation algorithm, where nodes are cloned and preserve either in-group or out-group relationships. Furthermore, we will define the generalized model of the Iterative Independent Model, specifically exploring the spectral gap of graphs in this model.

HERMIE MONTERDE, University of Manitoba
[Sunday December 3 / dimanche 3 décembre, 9:00 – Creation]
Hadamard diagonalizability and generalizations

An n-by-n matrix H is a *Hadamard* matrix if $HH^T = nI$. We say that a matrix M is *Hadamard diagonalizable* if $M = \frac{1}{n}HDH^T$ for some diagonal matrix D. In the context of graphs, we say that a graph X is *Hadamard diagonalizable* if its Laplacian matrix L is Hadamard diagonalizable. In this talk, we give an overview of results about the properties of Hadamard diagonalizable matrices and graphs, and discuss some generalizations. This talk is based on the work of Barik et al. (2011), Johnston et al. (2017), Chan et al. (2020), Breen et al. (2022), and McLaren et al. (2023).

FRÉDÉRIC MORNEAU-GUÉRIN, TELUQ
[Sunday December 3 / dimanche 3 décembre, 10:00 – Creation]
The diameter of the Birkhoff polytope

The geometry of the compact convex set of all $n \times n$ doubly stochastic matrices, a structure frequently referred to as the Birkhoff polytope, has been an active subject of research as of late. While its faces, edges and facets as well as its volume have been intensely studied over the years, other geometric characteristics with respect to usual matrix norms have only recently been studied in depth. In this talk, we shall explore the question of determining the diameter of the Birkhoff polytope with respect to the metrics induced by the operator norms from ℓ_n^p to ℓ_n^p and the Schatten p-norms, both for the range $1 \leq p \leq \infty$.

PAUL SKOUFRANIS, York University
[Sunday December 3 / dimanche 3 décembre, 16:30 – Creation]
Matrix Majorization in Non-Commutative Contexts

The notion of majorization of one self-adjoint $n \times n$ matrix by another is a very useful concept in matrix theory. For example, a classical theorem of Schur and Horn states that a diagonal matrix D is majorized by a self-adjoint matrix B if and only if a unitary conjugate of B has the same diagonal as D. Some equivalent characterizations of A being majorized by B include

there existing a doubly stochastic matrix that maps the vector or eigenvalues of B to the the vector or eigenvalues of A, tracial inequalities involving convex functions of A and B, and there exists a mixed unitary quantum channel that maps B to A.

In this talk, we will examine the notion of majorization in other non-commutative contexts. In particular, we will discuss a generalization of matrix majorization that works in any C*-algebra, and a new non-commutative notion of majorization that characterizes the potential outputs under all unital quantum channels of any non-commutative tuple of matrices.

This talk is based on joint works with Ng and Robert, and with Kennedy and Marcoux.

HEATHER SWITZER, The College of William & Mary
[Sunday December 3 / dimanche 3 décembre, 15:30 – Creation]
Exploring the Advantages of Using Sketched Krylov Methods in PRIMME

In recent years, sketching methods have increased in popularity for large scale least-squares problems. This is due to the scalability and reliability of randomized subspace embeddings which turn a large problem into something more managable with minimal loss of accuracy in the solutions. It had been observed that Rayleigh-Ritz approaches in Krylov iterative methods can be written as a least-squares problem, and therefore may benefit from the use of sketching to extract approximate solutions from the eigenspace.

One known pitfall of Krylov methods is that as the Krylov basis is being built, the condition number can grow exponentially due to numerical error and repeated directions occurring. Theoretically, we can reorthogonalize the basis using techniques such as Gram-Schmidt or the QR decomposition. However, in practice, these methods are expensive to execute and result in a computational bottleneck, particularly when looking for a large number of eigenpairs.

One benefit of using sketching in conjunction with Krylov methods is that we can avoid having to reorthogonalize our basis frequently. In theory, as long as the condition number of the basis remains below $\epsilon_{\texttt{mach}}$, sketched Rayleigh-Ritz should produce accurate Ritz vectors. Using the eigensolver software package PRIMME, we explore the benefits and disadvantages of using sketching with two popular Krylov methods, Lanczos and Davidson.

MICHAEL TAIT, Villanova University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Creation]
Counting subgraphs using graph eigenvalues

We discuss how to use graph eigenvalues to count subgraphs of various graphs. We discuss the general framework of this problem and how it captures several problems in extremal graph theory, and then we show how to use graph eigenvalues to answer the problem in specific cases. Some applications include to combinatorial number theory, to geometric questions in graph theory, and to VC dimension.

IAN THOMPSON, University of Manitoba
[Sunday December 3 / dimanche 3 décembre, 16:00 – Creation]
Peaking phenomena in finite-dimensions

Complex function theory is a powerful tool for studying operators. Indeed, this is at the heart of numerous applications of the spectral theorem (functional calculi, von Neumann's inequality), as well as countless modern developments. We focus on one connection to function theory that has garnered significant interest in recent years: non-commutative peak points. Their interest is, in part, justified by their ability to detect intrinsic components of a subspace of operators. In this talk, we will discuss a few formulations of peaking, with a particular focus on spaces of matrices. This includes joint work with Raphaël Clouâtre.

Advancements in Matrix Theory with Applications

AMY YIELDING, Eastern Oregon University
[Saturday December 2 / samedi 2 décembre, 9:00 – Creation]
An Investigation of Coefficient Sign Arbitrary Patterns

A square zero-nonzero pattern, $\mathcal{A}$, is a square matrix with entries in $\{0, *\}$. Such a pattern is said to be coefficient support arbitrary if for every $S \subseteq \{1, 2, \ldots, n\}$ there is a matrix A with zero-nonzero pattern $\mathcal{A}$ such that $\alpha_i \neq 0$ if and only if $i \in S$, where $x^n + \alpha_1 x^{n-1} + \alpha_2 x^{n-2} + \ldots + \alpha_{n-1} x + \alpha_n$ is the characteristic polynomial of A. In this talk, we naturally extend this definition to coefficient sign arbitrary patterns and explore some initial results.

HARMONY ZHAN, Worcester Polytechnic Institute
[Saturday December 2 / samedi 2 décembre, 17:30 – Creation]
Spectra of line digraphs and their applications

The line digraph of a graph X has all arcs of X as its vertices, and an arc (a, b) is adjacent to an arc (c, d) if $b = c$. In this talk, we will explore the spectra of some matrix representations of line digraphs, and see a few applications where X is highly regular.

XIAOHONG ZHANG, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 17:00 – Creation]
Laplacian cospectral graphs

In this talk, we present a way of constructing Laplacian cospectral graphs by deleting edges of smaller Laplacian cospectral graphs from certain graphs. This has applications in subgraph transfer of continuous time quantum walks.

Algebraic Graph Theory for Walking on Graphs
Théorie algébrique des graphes pour la marche sur les graphes

Org: Sooyeong Kim (York University), **Hermie Monterde** (University of Manitoba), **Christopher Van Bommel** (Guelph University), **Harmony Zhan** (Worcester Polytechnic Institute) and/et **Xiaohong Zhang** (Université de Montréal)

The study of walks on graphs, particularly quantum walks and random walks, has become increasingly relevant in both pure and applied mathematics mainly due to their useful applications, especially in quantum computing and network science. Algebraic graph theory is the application of algebraic methods, broadly construed, to the study of graphs. Over the years, the use of techniques from algebraic graph theory has produced many beautiful and interesting results in the study of walks on graphs. The goal of this scientific session is to bring together mathematicians working in the interplay of these two areas to discuss their recent work, disseminate new ideas, and hopefully inspire future collaborations.

Schedule/Horaire — Room/Salle: Symphonie 4B

Sunday December 3 — dimanche 3 décembre

8:00 - 8:30	Harmony Zhan (Worcester Polytechnic University), *ϵ-uniform mixing in discrete quantum walks* (p. 57)
8:30 - 9:00	Neal Madras (York University), *Must random walk move rapidly on either a graph or its complement ?* (p. 56)
9:00 - 9:30	Mariia Sobchuk (University of Waterloo), *Quantum isomorphisms* (p. 57)
9:30 - 10:00	Sooyeong Kim (York University), *Kemeny's constant and enumerating Braess edges in trees* (p. 55)
10:00 - 10:30	Paula Kimmerling (Washington State University), *Continuous-Time Quantum Walks on Windmill Graphs* (p. 55)
15:00 - 15:30	Chris Godsil (University of Waterloo), *Coefficient Matrices* (p. 55)
15:30 - 16:00	Christopher van Bommel (University of Guelph), *Fidelities and Readout Times of Quantum State Transfer* (p. 57)
16:00 - 16:30	Luc Vinet (Université de Montréal), *m-distance regular graphs and multivariate P-polynomial association schemes* (p. 57)
16:30 - 17:00	Yujia Shi (Northeastern University), *Quantifying Transfer Strength on Graphs with Finite Cospectrality* (p. 56)
17:00 - 17:30	Gabor Lippner (Northeastern University), *Instability of transfer strength* (p. 56)
17:30 - 18:00	Christino Tamon (Clarkson University), *Do quantum walks obey speed limits ?* (p. 57)

Monday December 4 — lundi 4 décembre

8:00 - 8:30	Xiaohong Zhang (Universite de Montreal), *Local uniform mixing* (p. 58)
8:30 - 9:00	David Feder (University of Calgary), *Two-step perfect quantum state transfer on graphs* (p. 54)
9:00 - 9:30	Aysa Tajeri (York University), *Pretty good state transfer on cycles* (p. 57)
9:30 - 10:00	Mark Kempton (Brigham Young University), *Non-backtracking random walks: mixing rate, Kemeny's constant, and related parameters* (p. 55)
10:00 - 10:30	Adam Knudson (Brigham Young University), *A Nordhauss-Gaddum type problem for the normalized Laplacian spectrum and graph Cheeger constant* (p. 56)

Abstracts/Résumés

DAVID FEDER, University of Calgary
[Monday December 4 / lundi 4 décembre, 8:30 – Symphonie 4B]
Two-step perfect quantum state transfer on graphs

Algebraic Graph Theory for Walking on Graphs
Théorie algébrique des graphes pour la marche sur les graphes

The criteria for the perfect state transfer (PST) of a quantum state between two vertices of a graph via a continuous-time quantum walk (QW) are now well-established ; as these are quite restrictive, only a relatively small number of examples have been found to date. I will discuss an extension of the procedure that allows for perfect transfer between otherwise forbidden vertices, where the QW proceeds in two steps with different choices of edge weights and evolution times for each step. In all cases considered, there exists a specific choice of parameters where edge weights for the second step can be related to those in the first step via switching to a signed graph, equivalent to a unitary transformation on the graph adjacency matrix comprised only of diagonal elements ± 1. Extending the two-step PST to multiple initial and final vertices permits the perfect preparation of maximal eigenstates of the adjacency matrices of induced subgraphs via quantum walk.

CHRIS GODSIL, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 15:00 – Symphonie 4B]
Coefficient Matrices

If we are working with characteristic polynomials of graphs and X is a graph on n vertices, its *coefficient matrix* if the $n \times n$ matrix whose i-th row is the vector of coefficients of the characteristic polynomial $\phi(x \setminus i, t)$ of the i-th vertex-deleted subgraph of X.

There is an analog based on matching polynomials. Let $p(X, k)$ denote the number of matchings of X. The *matching polynomial* of X is

$$\mu(X, t) = \sum_{k \geq 0} (-1)^{n-2k} p(X, k) t^{n-2k}.$$

Matching polynomials share many of the properties of characteristic polynomials—for example their zeros are real, and the matching polynomial of a forest is equal to its characteristic polynomial. In the context of matching polynomials, the *coefficient matrix* has the coefficients of the polynomials $\mu(X \setminus i, t)$ as its rows.

My talk will introduce these matrices. I will present an application of the characteristic coefficient matrix to a graph invariant arising from continuous quantum walks, and an application of the matching coefficient matrix to the construction of pairs of non-isomorphic graphs with the same matching polynomial.

MARK KEMPTON, Brigham Young University
[Monday December 4 / lundi 4 décembre, 9:30 – Symphonie 4B]
Non-backtracking random walks: mixing rate, Kemeny's constant, and related parameters

We will discuss non-backtracking random walks on graphs and spectral properties of matrices associated with them. We will see how many parameters and ideas coming from the theory of random walks on graphs can be modified by a non-backtracking random walk. We will compare these non-backtracking parameters with the usual simple random walk analogues.

SOOYEONG KIM, York University
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 4B]
Kemeny's constant and enumerating Braess edges in trees

We study the problem of enumerating Braess edges for Kemeny's constant in trees. We obtain bounds and asympotic results for the number of Braess edges in some families of trees.

PAULA KIMMERLING, Washington State University
[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 4B]
Continuous-Time Quantum Walks on Windmill Graphs

Let A be the adjacency matrix of a graph. We will associate this graph with a continuous-time quantum walk by using a transition matrix $U(t) = e^{itA}$. This allows us to create another matrix $\hat{M}$ which is time-independent. $\hat{M}$ gives us some

measure of average probability values of a continuous time quantum walk and is called the average mixing matrix. This has been studied extensively on trees and other graphs with distinct eigenvalues.

Our work focuses on graphs which have repeated eigenvalues. In addition to studying the rank and long-term behavior of Dutch Windmill graphs, we extended that same study to French Windmill graphs and Kulli Cycle Windmills. We will compare the behavior of the Windmill graphs to see which ones allow greater transfer of quantum information.

ADAM KNUDSON, Brigham Young University
[Monday December 4 / lundi 4 décembre, 10:00 – Symphonie 4B]
A Nordhauss-Gaddum type problem for the normalized Laplacian spectrum and graph Cheeger constant

For a graph G on n vertices with normalized Laplacian eigenvalues $0 = \lambda_1(G) \leq \lambda_2(G) \leq \cdots \leq \lambda_n(G)$ and graph complement G^c, we prove that

$$\max\{\lambda_2(G), \lambda_2(G^c)\} \geq \frac{2}{n^2}.$$

We do this by way of lower bounding $\max\{i(G), i(G^c)\}$ and $\max\{h(G), h(G^c)\}$ where $i(G)$ and $h(G)$ and denote the isoperimetric number and Cheeger constant of G, respectively.

GABOR LIPPNER, Northeastern University
[Sunday December 3 / dimanche 3 décembre, 17:00 – Symphonie 4B]
Instability of transfer strength

We study the maximum achievable state transfer strength in a scenario where magnetic fields are applied to 3 nodes: the source and the target, as well as a third one. It turns out, this setup behaves in a more subtle way than the case when only the source and the target node receive magnetic fields (that will be described in some detail in Yujia Shi's talk). In particular, we are able to exhibit an instability phenomenon that is absent in the original case: changing the graph structure arbitrarily far from the source and target can lead to a significant increase in the maximum transfer strength.

NEAL MADRAS, York University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Symphonie 4B]
Must random walk move rapidly on either a graph or its complement ?

One way to measure how rapidly a random walk moves around a graph G is by the Kemeny constant of the graph. Roughly speaking, if G has n vertices and its Kemeny constant is $O(n)$, then a random walk is not slow to visit a randomly chosen target vertex.

I shall outline a proof that for every $\epsilon > 0$, there is a constant Ψ with the following property: If G has n vertices, and every vertex has degree between ϵn and $(1 - \epsilon)n$, then either G or its complement has its Kemeny constant less than Ψn. The methods are mainly probabilistic, with the spectral gap playing a key role. Some stronger results and open questions will also be described.

This is based on joint work with Sooyeong Kim, Ada Chan, Mark Kempton, Steve Kirkland, and Adam Knudson.

YUJIA SHI, Northeastern University
[Sunday December 3 / dimanche 3 décembre, 16:30 – Symphonie 4B]
Quantifying Transfer Strength on Graphs with Finite Cospectrality

Exploring quantum state transfer dynamics on graphs with finite cospectrality, we expand upon Lin, Yau, and Lippner's work: when vertex cospectrality exceeds distance, quantum state transfer is certain with increasing energy potential. This talk will examine cospectrality versus distance in various scenarios, offering strategies to ensure reliable transfer fidelity within specified

potential limits. Additionally, a brief discussion addresses the critical aspect of readout time, providing insights for optimizing quantum information transfer efficiency.

MARIIA SOBCHUK, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 4B]
Quantum isomorphisms

You will learn about recent progress in the area of quantum isomorphisms (as the title unambiguously suggests).

AYSA TAJERI, York University
[Monday December 4 / lundi 4 décembre, 9:00 – Symphonie 4B]
Pretty good state transfer on cycles

H. Pal and B. Bhattacharjya have proved, using the adjacency matrix, that the continuous-time quantum walk of a cycle C_n admits pretty good state transfer if and only if $n = 2^k$.
The exponential distance matrix of a graph is defined entry-wise by letting the (u, v)-entry be $q^{dist(u,v)}$ for some parameter q. Using exponential distance matrix as the Hamiltonian of the walk, we show that all the even cycles admit pretty good state transfer.

CHRISTINO TAMON, Clarkson University
[Sunday December 3 / dimanche 3 décembre, 17:30 – Symphonie 4B]
Do quantum walks obey speed limits ?

Are there speed limits for state transfer in continuous-time quantum walks ? We focus on weighted paths as explicit bounds are known for perfect state transfer (due to Yung and Kay). A simple generalization to fractional revival is described. Then, we briefly discuss violations of these speed limits (within the legal bounds of quantum physics). Along the way, we mention a few other related observations (paradoxical or otherwise) and conclude with some open questions. This talk is based on work done with Alastair Kay and Weichen Xie.

CHRISTOPHER VAN BOMMEL, University of Guelph
[Sunday December 3 / dimanche 3 décembre, 15:30 – Symphonie 4B]
Fidelities and Readout Times of Quantum State Transfer

Continuous-time quantum walks on graphs are a model for the propagation of quantum states in a quantum system. Of particular interest is the measure of the fidelity of transmission, the probability of success of transmitting a quantum state between a source site and a destination site in a given time interval. A fidelity of 1 is the well-known property of perfect state transfer and achieving fidelities arbitrarily close to 1 is the well-known property of pretty good state transfer. In general, time intervals for pretty good state transfer are not explicitly determined. We discuss recent developments regarding classes of graphs for which explicit fidelities of state transfer approaching 1, as well as the required time intervals, can be determined. Joint work with Steve Kirkland.

LUC VINET, IVADO/CRM, Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 16:00 – Symphonie 4B]
m-distance regular graphs and multivariate P-polynomial association schemes

The notion of m-distance regular graphs is introduced and related to multivariate P-polynomial schemes.

Work done in collaboration with Pierre-Antoine Bernard, Nicolas Crampé, Meri Zaimi and Xiahong Zhang.

Algebraic Graph Theory for Walking on Graphs
Théorie algébrique des graphes pour la marche sur les graphes

---

HARMONY ZHAN, Worcester Polytechnic Institute
[Sunday December 3 / dimanche 3 décembre, 8:00 – Symphonie 4B]
ϵ-uniform mixing in discrete quantum walks

If a discrete quantum walk starts with a superposition of outgoing arcs of some vertex, can it get arbitrarily close to a state whose amplitudes have the same absolute value over all the arcs? We investigate this phenomenon in arc-reversal Grover walks on distance regular graphs. In particular, if this happens on a non-bipartite distance regular graph, and the target state respects the neighborhoods, then the Bose-Mesner algebra contains a real Hadamard matrix. This gives rise to 4 infinite families of strongly regular graphs that admit ϵ-uniform mixing.

XIAOHONG ZHANG, Université de Montréal
[Monday December 4 / lundi 4 décembre, 8:00 – Symphonie 4B]
Local uniform mixing

Let X be a graph with adjacency matrix A, then the transition matrix for the continuous time quantum walk on X at time t is given by

$$U(t) = \exp(itA).$$

If for some time t, the j-th column of $U(t)$ is flat (all the entries of the column have the same modulus), then we say X admits local uniform mixing with respect to vertex j at time t. We construct an infinite family of graphs that admits local uniform mixing. They also serve as examples where local uniform mixing at vertex u does not necessarily occur at a rational multiple of the period if X is also periodic at vertex u. We also present some graphs that admit local uniform mixing with respect to several vertices at the same time, but those vertices are not in the same orbit.

This is joint work with Chris Godsil.

Algebraic and Enumerative Combinatorics
Combinatoires algébrique et énumérative

Org: Alejandro Morales (Université du Québec à Montréal (UQAM)) and/et **Mohamed Omar** (York University)

Description: Recent trends in algebraic and enumerative combinatorics have opened doors to promising techniques to resolve central questions in the fields. Furthermore, methods from disparate areas of algebra and geometry have shed light on novel approaches to problems that have previously been intractable. This session brings together combinatorialists to share their developments in these recent trends.

Schedule/Horaire **Room/Salle: Symphonie 3B**

Sunday December 3 — dimanche 3 décembre

8:30 - 9:00	Angele Foley (Wilfrid Laurier), *H-Chromatic Symmetric Functions* (p. 62)
9:00 - 9:30	Kelvin Chan (York University), *A cocharge folklore and super coinvariant spaces* (p. 61)
9:30 - 10:00	Lucas Gagnon (York University), *The shadows of quasisymmetric Templerley—Lieb coinvariants are noncrossing partitions* (p. 62)
10:00 - 10:30	Farid Aliniaeifard (UBC), *Generalized chromatic functions* (p. 60)
15:00 - 15:30	GaYee Park (UQAM), *Generalized parking function* (p. 62)
15:30 - 16:00	Jeremy Chizewer (Waterloo), *Enumeration and Compact Encoding of AVL Trees* (p. 61)
16:00 - 16:30	Sam Hopkins (Howard University), *Combinatorial reciprocity for non-intersecting paths* (p. 62)
16:30 - 17:00	Karen Yeats (Waterloo), *Combinatorial interpretation of the coefficients of the BDG action* (p. 63)
17:00 - 17:30	Dave Anderson (Ohio State University), *New formulas for Schubert polynomials via bumpless pipe dreams* (p. 60)
17:30 - 18:00	Prateek Vishwakarma (University of Regina), *Plücker inequalities for weakly separated coordinates in totally nonnegative Grassmannian* (p. 63)

Monday December 4 — lundi 4 décembre

8:30 - 9:00	Spencer Backman (Vermont), *Higher Categorical Associahedra* (p. 60)
9:00 - 9:30	Gabe Udell (Cornell), *Degenerating brick manifolds and subdividing the associahedron* (p. 63)
9:30 - 10:00	Jose Bastidas (UQAM), *Alcoved signed permutations* (p. 60)
10:00 - 10:30	Marie Albenque (IRIF, Université Paris Cité), *Bijective proof of rational enumerative schemes for maps on the torus of genus g.* (p. 59)
15:30 - 16:00	Sarah Brauner (UQAM), *Card shuffling, derangements, and q-analogues* (p. 61)
16:00 - 16:30	Jonathan Boretsky (Harvard), *The Totally Nonnegative Tropical Flag Variety* (p. 61)
16:30 - 17:00	Franco Saliola (UQAM), *Left Regular Bands of Groups and the Mantaci-Reutenauer Algebra* (p. 62)

Abstracts/Résumés

MARIE ALBENQUE, CNRS – Université Paris cité

[Monday December 4 / lundi 4 décembre, 10:00 – Symphonie 3B]

Bijective proof of rational enumerative schemes for maps on the torus of genus g.

Maps are graphs embedded into surfaces. Their study started in the 60s with Tutte's work, in which he obtained many closed enumerative formulas for the planar case (i.e. when the surface is the sphere). These formulas, obtained by highly non trivial computations, are remarkably simple. To explain this simplicity, some bijections between planar maps and certain families of decorated trees were obtained (among others !) by Cori and Vauquelin in 1981 and by Schaeffer in 1997 and 1998

When the underlying surface is the torus with g holes, in 1991 Bender and Canfield obtained, followed by Bender, Canfield and Richmond in 1993, obtained some formulas analogous to Tutte's ones, but in the form of a rationality scheme valid for any g.

In this talk, I will give the first bijective derivation of their result, which consists in an extension of Schaeffer's bijection to the torus.

This is based on a joint work with Mathias Lepoutre.

FARID ALINIAEIFARD, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 3B]
Generalized chromatic functions

We define vertex-colourings for edge-partitioned digraphs, which unify the theory of P-partitions and proper vertex-colourings of graphs. We use our vertex-colourings to define generalized chromatic functions, which merge the chromatic symmetric and quasisymmetric functions of graphs and generating functions of P-partitions. Moreover, generalized chromatic functions can refine the (3+1)-free conjecture and the Tree Conjecture. We discuss several open problems related to the refinement of the conjectures.

DAVE ANDERSON, Ohio State University
[Sunday December 3 / dimanche 3 décembre, 17:00 – Symphonie 3B]
New formulas for Schubert polynomials via bumpless pipe dreams

The last five years have seen many applications of the "bumpless pipe dreams" (BPDs) introduced in Lam-Lee-Shimozono's seminal paper on back stable Schubert polynomials. I will report on joint work with William Fulton, in which we obtain a decomposition of the Schubert polynomial as a sum of "drift polynomials". The new formula has several pleasant features: 1) in many cases, it allows efficient computation of the Schubert polynomial ; 2) the constituent drift polynomials have tableau formulas, and can (sometimes) be written naturally as Lindström-Gessel-Viennot determinants ; and 3) nearly without change, the same formula computes the enriched Schubert polynomials, which specialize to the back stable ones. I'll also demo some software for working with BPDs.

SPENCER BACKMAN, University of Vermont
[Monday December 4 / lundi 4 décembre, 8:30 – Symphonie 3B]
Higher Categorical Associahedra

The associahedron is a well-known polytope with connections to many different areas of combinatorics, algebra, geometry, topology, and physics. The associahedron has Catalan number many vertices which can be equivalently described in terms of triangulations of a polygon, planar binary trees, maximal parenthesizations of a word, etc. From one perspective, the associahedron encodes the combinatorics of morphisms in the Fukaya category of a symplectic manifold. In 2017, Bottman introduced a family of posets called 2-associahedra which encode the combinatorics of functors between Fukaya categories, and he conjectured that they can be realized as the face posets of convex polytopes. We will begin by reviewing the basic theory of associahedra. We will then introduce categorical n-associahedra as a natural extension of associahedra and 2-associahedra, and we will produce a family of complete polyhedral fans called velocity fans whose face posets are the categorical n-associahedra. This is joint work with Nathaniel Bottman and Daria Poliakova.

JOSE BASTIDAS, LACIM-UQAM
[Monday December 4 / lundi 4 décembre, 9:30 – Symphonie 3B]
Alcoved signed permutations

We introduce a new partial order on signed permutations whose cover relations are determined by certain *big ascents*. Its Hasse diagram is dual to the alcove triangulation of the fundamental parallelepiped of the type C root system, as studied by Lam

and Postnikov. This duality allows us to use Ehrhart theory to obtain a generating function for big ascents and, conversely, to combinatorially interpret the coefficients of h^*-polynomial of the type C half-open hypersimplices. We also obtain a relation between the distribution of covers in our poset and the usual descents in the "half" weak order of type BC. Moreover, we show that these family of posets converges, in a precise sense, to the lattice of strict partitions. This is based on joint work with Antoine Abram.

JONATHAN BORETSKY, Harvard University
[Monday December 4 / lundi 4 décembre, 16:00 – Symphonie 3B]
The Totally Nonnegative Tropical Flag Variety

The flag variety of rank $r = (r_1, \ldots, r_k)$ has points corresponding to collections of subspaces $(V_1, \ldots, V_k)$ with V_i of dimension r_i such that V_i is contained in V_{i+1}. We explore two nonnegative versions of this variety: First, we study the nonnegative flag variety, which corresponds to a subset of the flag variety consisting of flags that can be represented by totally positive matrices. Second, we study the tropicalization of the flag variety and, more specifically, its nonnegative part. In both cases, we provide equivalent descriptions of these spaces for flag varieties of rank $r = (a, a+1, \ldots, b)$, where r consists of consecutive integers. This talk is based on joint work with Chris Eur and Lauren Williams.

SARAH BRAUNER, UQAM
[Monday December 4 / lundi 4 décembre, 15:30 – Symphonie 3B]
Card shuffling, derangements, and q-analogues

How many times do you need to shuffle a deck of cards to ensure it is adequately mixed ? This is a question in probability theory, but for many methods of card shuffling, the answer relies on combinatorics and representation theory. In this talk, I will discuss several classical card-shuffling processes and introduce their q-analogues, which can be understood as random walks on the (Type A) Hecke algebra. Motivated by questions of mixing times, I will present recent results and conjectures concerning the eigenvalues and eigenspaces of these (q-)shuffling operators. Along the way we will see derangements, desarrangements, and tableau combinatorics. This is joint work with Commins and Reiner, as well as Axelrod-Freed, Chiang, Commins and Lang.

KELVIN CHAN, York University
[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 3B]
A cocharge folklore and super coinvariant spaces

It is well-known that the major index maj and the cocharge statistics chr of standard tableaux are equidistributed. It is also well-known that maj and chr are related to bases of the classical coinvariant spaces. In this talk, we consider a generalization of the classic coinvariant spaces called the super coinvariant spaces. We motivate and discuss a folklore that refines the equidistrubition of maj and chr. Finally, we discuss some open problems in super coinvariant spaces.

JEREMY CHIZEWER, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 15:30 – Symphonie 3B]
Enumeration and Compact Encoding of AVL Trees

An AVL tree is a type of self-balancing binary search tree commonly used in computer science. From an enumerative perspective, an AVL tree is a rooted planar binary tree such that the heights of the left and right subtrees at any node differ by at most one. Because AVL trees are most easily recursively decomposed by height instead of by number of nodes, their enumeration is more difficult than other classes of recursively defined trees.

Motivated by a desire to derive the information-theoretic lower bound on the number of bits needed to encode an AVL tree, we develop a new method for the study of combinatorial classes whose generating functions satisfy certain functional equations

and use this tool to derive the growth rate of AVL trees and related structures. We also describe a new encoding for AVL trees that uses less than one bit per node.

Joint work with Stephen Melczer, J. Ian Munro, and Ava Pun.

ANGELE FOLEY, Wilfrid Laurier University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Symphonie 3B]
H-Chromatic Symmetric Functions

We recently introduced H-chromatic symmetric functions, X_G^H, which use the H-coloring of a graph G to define a generalization of Stanley's chromatic symmetric functions. In this talk we take a tour of these new symmetric functions, considering equivalence questions and basis questions. We also include conjectures and open problems.

This is joint work with N.M. Eagles, A. Huang, E. Karagozishvili, and A. Yu.

LUCAS GAGNON, York University
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 3B]
The shadows of quasisymmetric Templerley—Lieb coinvariants are noncrossing partitions

In the early 2000s, Hivert and Aval, Bergeron, and Bergeron found compelling evidence that the Templerley—Lieb algebra $\mathrm{TL}_n(2)$ and the quasisymmetric polynomials QSym_n in $R = \mathbb{C}[x_1, \ldots, x_n]$ should have a coinvariant theory much like the symmetric group and symmetric polynomials. Unfortunately, pinning down the details of this relationship is harder than expected, and a $\mathrm{TL}_n(2)$ action on $R/\langle \mathrm{QSym}_n^+ \rangle$ has eluded description for almost 20 years. I will describe how noncrossing partitions can take us from the Templerley—Lieb algebra to quasisymmetric polynomials and back, moving one step closer to a true coinvariant theory along the way. Based on joint work with Nantel Bergeron.

SAM HOPKINS, Howard University
[Sunday December 3 / dimanche 3 décembre, 16:00 – Symphonie 3B]
Combinatorial reciprocity for non-intersecting paths

Combinatorial reciprocity is when the counting function for one enumeration problem, evaluated at negative inputs, yields the counting function for another, related problem. We prove a combinatorial reciprocity result for the enumeration of non-intersecting paths in a linearly growing sequence of acyclic planar networks. We explain two applications of this theorem: reciprocity for fans of bounded Dyck paths, and reciprocity for Schur function evaluations with repeated values. This talk is based on joint work with Gjergji Zaimi.

GAYEE PARK, UQAM
[Sunday December 3 / dimanche 3 décembre, 15:00 – Symphonie 3B]
Generalized parking function

The "classical" parking functions of length n is counted by the formula $(n+1)^{n-1}$. They corresponds bijectively to the standard Young tableaux (SYT) of skew-shape $\alpha + 1^n/\alpha$, where α is any partition under $\lambda = (n-1, \ldots, 2, 1)$. There is a natural symmetric group action on these parking functions, where the orbit is counted by the Catalan number $1/(n+1)\binom{2n}{n}$. The Frobenius character of this action over all SYT of shape $\alpha + 1^n/\alpha$ is given by the skew Schur function $s_{(\alpha+1^n/\alpha)}(\mathbf{x})$. In this talk we generalize this notion to any partition λ and study the combinatorics of the generalized parking function by relating them to non-crossing lattice paths. This is a joint work with François Bergeron and Yan Lanciault.

Algebraic and Enumerative Combinatorics
Combinatoires algébrique et énumérative

FRANCO SALIOLA, LACIM / UQAM
[Monday December 4 / lundi 4 décembre, 16:30 – Symphonie 3B]
Left Regular Bands of Groups and the Mantaci-Reutenauer Algebra

In a highly influential paper, Bidigare, Hanlon and Rockmore showed that a number of popular Markov chains are random walks on the faces of a hyperplane arrangement. The analysis of these Markov chains takes advantage of the monoid structure on the set of faces. This theory was later extended by Brown to a larger class of monoids called left regular bands (LRBs).

This talk will explore a generalization called *LRBs of Groups* (LRBGs) that delightfully mixes LRBs and group theory. The principal example throughout will be a LRBG defined by S. Hsiao, which links the braid arrangement with the Mantaci-Reutenauer algebra. The talk is based on joint work with Jose Bastidas and Sarah Brauner.

GABE UDELL, Cornell University
[Monday December 4 / lundi 4 décembre, 9:00 – Symphonie 3B]
Degenerating brick manifolds and subdividing the associahedron

The associahedron is a convex polytope which pops up all over mathematics. Loday gave a realization of the associahedron as a lattice polytope ; Loday's associahedron has subsequently been understood as an example of a brick polytope. Brick polytopes are defined from subword complexes and they give polytopal realizations of certain subword complexes. Escobar associated to each subword complex a smooth sub-variety of a Bott-Samelson variety, which she called a brick manifold, and she showed that the brick polytope is the moment polytope of the brick manifold. In particular, Escobar constructed the toric variety of Loday's associahedron as a brick manifold. We describe a degeneration of any brick manifold and show that in the special case of the toric variety of the associahedron, the degeneration induces a polyhedral subdivision of the associahedron into cubes.

This is joint work with Raj Gandhi.

PRATEEK VISHWAKARMA, University of Regina
[Sunday December 3 / dimanche 3 décembre, 17:30 – Symphonie 3B]
Plücker inequalities for weakly separated coordinates in totally nonnegative Grassmannian

We show that the partial sums of the long Plücker relations for pairs of weakly separated Plücker coordinates oscillate around 0 on the totally nonnegative part of the Grassmannian. Our result subsumes the classical oscillating inequalities by Gantmacher–Krein (1941) and recent results on totally nonnegative matrix inequalities by Fallat–Vishwakarma (2023). In fact we obtain a characterization of weak separability, by showing that no other pair of Plücker coordinates satisfies this property.

KAREN YEATS, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 16:30 – Symphonie 3B]
Combinatorial interpretation of the coefficients of the BDG action

Causal set theory is a model of quantum gravity where the underlying spacetime is a locally finite poset. The Benincasa-Dowker-Glaser (BDG) action is an action on a causal set which corresponds to the classical Einstein-Hilbert action. L.Glaser gave formulas for the coefficients of the BDG action. I will give a combinatorial interpretation for these coefficients in terms of some lattice walks, and explain some consequences. No familiarity with causal set theory is required.

Algebraic, Arithmetic and Kahler Geometry: Recent developments

Org: Xi Chen (University of Alberta), **Nathan Grieve** (Acadia U./Carleton U./UQAM/U. Waterloo) and/et **Adrien Zahariuc** (University of Windsor)

There is a strong interplay amongst the areas of Algebraic, Arithmetic and Kahler Geometry. The main objects of interest are complex projective manifolds and the modern day framework in which these disciplines operate are made possible by foundational contributions of Riemann, Zariski, Weil, Chern and their schools. The respective disciplines employ algebraic, number theoretic and differential analytic tools to make progress towards the birational classification problem, the question of existence, distribution and complexity of rational and integral points within projective varieties, and finally the questions of moduli and stability (in their many flavours). The proposed session will provide an opportunity for researchers, at all career stages— including graduate students, postdoctoral fellows and early career researchers— who are working in these deep overlapping, foundational and continually developing areas of pure and applied mathematics to report on their recent and ongoing programs. An exciting aspect of the proposed session is that it seeks to bring together researchers, to Montreal, from all parts of Canada.

Schedule/Horaire — Room/Salle: Symphonie 2B

Saturday December 2 — samedi 2 décembre

8:00 - 8:30	Sam Payne (University of Texas), *Cohomology groups of moduli spaces of curves* (p. 66)
8:30 - 9:00	Steven Lu (UQAM), *Rigidity of maps into moduli space of polarized varieties* (p. 66)
9:00 - 9:30	Debaditya Raychaudhury (University of Arizona), *On the singularities of secant varieties* (p. 66)
9:30 - 10:00	Ethan Ross (University of Toronto), *Singular Reduction of Polarizations* (p. 67)
10:00 - 10:30	Changho Han (University of Waterloo), *Extending Torelli map from Smyth's alternative compactifications of the moduli of curves* (p. 65)
15:00 - 15:30	Zinovy Reichstein (UBC), *Essential dimension of symmetric groups in prime characteristic* (p. 67)
15:30 - 16:00	Dave Anderson (Ohio State University), *Refined transversality and equivariant positivity* (p. 65)
16:00 - 16:30	Katrina Honigs (SFU), *Hyperkahler varieties of Kummer type and torsion points of abelian surfaces* (p. 65)
16:30 - 17:00	Carlo Scarpa (UQAM), *The Einstein-Hilbert functional and K-stability* (p. 67)
17:00 - 17:30	Sasha Zotine (Queen's University), *Kawaguchi-Silverman Conjecture for Projective Bundles on Curves* (p. 67)

Sunday December 3 — dimanche 3 décembre

8:00 - 8:30	Andrew Harder (Lehigh University), *Tropical homology and mirror symmetry* (p. 65)
8:30 - 9:00	Michael Groechenig (University of Toronto), *p-adic integration, buildings and BPS invariants* (p. 65)
9:00 - 9:30	Julien Keller (UQAM), *Variational and non-archimedean aspects of the correspondence for vector bundles* (p. 66)
9:30 - 10:00	Houari Benammar Ammar (UQAM), *Slope inequality for an arbitrary divisor.* (p. 64)
10:00 - 10:30	Joel Kamnitzer (McGill University), *Moduli space of cactus flower curves* (p. 66)

Abstracts/Résumés

HOUARI BENAMMAR AMMAR, UQAM
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 2B]
Slope inequality for an arbitrary divisor.

Algebraic, Arithmetic and Kahler Geometry: Recent developments

In this talk, we explain a more general version of slope inequality for a fibred surface, we compute some natural examples, and we give applications. Our approach applies the theory of Harder-Narasimhan filtrations for vector bundles on curves and builds on the approach of G. Xiao.

DAVE ANDERSON, Ohio State University
[Saturday December 2 / samedi 2 décembre, 15:30 – Symphonie 2B]
Refined transversality and equivariant positivity

The standard Kleiman-Bertini transversality theorems say that if a variety is homogeneous with respect to the action of an algebraic group, this action moves any two subvarieties into transverse position. I will describe refinements which treat cases where the action is not transitive, along with an application to the positivity of cohomology and K-theory classes of subvarieties of a generalized flag variety.

MICHAEL GROECHENIG, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 8:30 – Symphonie 2B]
p-adic integration, buildings and BPS invariants

I will report on joint work in progress with Dimitri Wyss and Paul Ziegler, continuing our previous papers on the Hausel-Thaddeus conjecture and Ngô's geometric stabilisation theorem. In those articles, we applied Batyrev's technique of p-adic integration to the Hitchin system. A common feature of our previous two papers is that we worked with moduli spaces, which have at most quotient singularities. We achieved this either by imposing a coprimality assumption on rank and degree, or by restricting to the elliptic locus. Our new work sheds light on the geometric meaning of p-adic integration in the absence of those assumptions. We will see that the resulting theory is closely related to BPS invariants.

CHANGHO HAN, University of Waterloo
[Saturday December 2 / samedi 2 décembre, 10:00 – Symphonie 2B]
Extending Torelli map from Smyth's alternative compactifications of the moduli of curves

It is well-known that the Torelli map, that turns a smooth curve of genus g into its Jacobian (a principally polarized abelian variety of dimension g), extends to a map from the Deligne—Mumford moduli of stable curves to the moduli of semi-abelic varieties by Alexeev. Moreover, it is also known that the Torelli map does not extend over the alternative compactifications of the moduli of curves as described by the Hassett—Keel program, including the moduli of pseudostable curves (can have nodes and cusps but not elliptic tails). But it is not yet known whether the Torelli map extends over the Smyth's alternative compactifications of the moduli of curves ; what about the moduli of curves of genus g with rational m-fold singularities, where m is a positive integer bounded above ? As a joint work in progress with Jesse Kass and Matthew Satriano, I will describe two types of moduli of curves with m-fold singularities and describe how far the Torelli map extends over such spaces into the Alexeev compactifications.

ANDREW HARDER, Lehigh University
[Sunday December 3 / dimanche 3 décembre, 8:00 – Symphonie 2B]
Tropical homology and mirror symmetry

Tropical homology, introduced by Mikhalkin and Zharkov, gives a powerful combinatorial tool for describing Hodge numbers of projective varieties. In this talk, I will explain how one can use tropical homology to prove a conjecture of Katzarkov, Kontsevich, and Pantev for toric complete intersections. This is joint work in progress with Sukjoo Lee.

Algebraic, Arithmetic and Kahler Geometry: Recent developments

---

KATRINA HONIGS, Simon Fraser University
[Saturday December 2 / samedi 2 décembre, 16:00 – Symphonie 2B]
Hyperkahler varieties of Kummer type and torsion points of abelian surfaces

In this talk, I will describe the geometry of part of the middle cohomology of some hyperkahler varieties of Kummer type and the Galois action on it. I will then discuss how these results can be applied to find abelian surfaces whose generalized Kummer 4-folds are not derived equivalent, over a ground field of Q, to the generalized Kummer 4-folds of their duals.

JOEL KAMNITZER, McGill University
[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 2B]
Moduli space of cactus flower curves

I will discuss a variant on the Deligne Mumford space of genus 0 curves which parametrizes "cactus flower curves". This moduli space is constructed starting with the moduli space of flower curves, which is the matroid Schubert variety associated to the braid arrangement. The fundamental group of the real locus of this space is the virtual cactus group.

JULIEN KELLER, UQAM
[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 2B]
Variational and non-archimedean aspects of the correspondence for vector bundles

The famous correspondence for vector bundles, proved by Donaldson and Uhlenbeck-Yau states that the existence of Hermitian-Einstein metrics on a holomorphic vector bundle is equivalent to an algebro-geometric stability condition. Using a variational formulation, we will explain several results that provide a link between differential geometry and algebraic geometry in the above correspondence. Our approach is based on the study of an object called the Quot-scheme limit of Fubini-Study metrics, which is used to evaluate certain algebraic 1-parameter subgroups of Hermitian metrics by using the notion of Quot-schemes introduced by Grothendieck. We will present a dictionary between non-archimedean aspects related to the correspondence for bundles and non-archimedean aspects related to the Yau-Tian-Donaldson conjecture for varieties. This a joint work with Y. Hashimoto (Osaka).

STEVEN LU, UQAM
[Saturday December 2 / samedi 2 décembre, 8:30 – Symphonie 2B]
Rigidity of maps into moduli space of polarized varieties

I will present the the problem and the methodology of the solution of the rigidity of pointed maps from an arbitrary algebraic variety to the moduli space of polarized (smooth) good minimal models. This is joint work with Ariyan Javenpaykar, Ruiran Sun and Kang Zuo.

SAM PAYNE, University of Texas at Austin
[Saturday December 2 / samedi 2 décembre, 8:00 – Symphonie 2B]
Cohomology groups of moduli spaces of curves

The cohomology groups of moduli spaces of curves are important to several mathematical disciplines, from low-dimensional topology and geometric group theory to stable homotopy theory and quantum algebra. Algebraic geometry endows these groups with additional structures, such as Hodge structures and Galois representations, and the Langlands program makes striking predictions about which such structures can appear. I will survey recent results confirming several of these predictions and making progress toward calculating these groups and determining in which degrees they do and do not vanish.

Algebraic, Arithmetic and Kahler Geometry: Recent developments

DEBADITYA RAYCHAUDHURY, University of Arizona
[Saturday December 2 / samedi 2 décembre, 9:00 – Symphonie 2B]
On the singularities of secant varieties

In this talk, we study the singularities of secant varieties of smooth projective varieties when the embedding line bundle is sufficiently positive. We give a necessary and sufficient condition for these to have p-Du Bois singularities. In addition, we show that the singularities of these varieties are never higher rational. From our results, we deduce several consequences, including a Kodaira-Akizuki-Nakano type vanishing result for the reflexive differential forms of the secant varieties. Work in collaboration with S. Olano and L. Song.

ZINOVY REICHSTEIN, Department of Mathematics, University of British Columbia
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 2B]
Essential dimension of symmetric groups in prime characteristic

Computing the essential dimension of the symmetric group S_n is a long-standing open problem, originating in the work of Felix Klein. It is known that this number lies between $[n/2]$ and $n-3$ for any $n \geqslant 5$. The exact value is not known for any $n \geqslant 8$, though it is expected to be $n-3$ for every $n \geqslant 5$, at least in characteristic 0. The main result of this talk, based on joint work with Oakley Edens, is that for odd prime p there are infinitely many positive integers n such that the essential dimension of S_n is $\leqslant n-4$ in characteristic p.

ETHAN ROSS, University of Toronto
[Saturday December 2 / samedi 2 décembre, 9:30 – Symphonie 2B]
Singular Reduction of Polarizations

A polarization on a symplectic manifold (M, ω) is an involutive complex Lagrangian subbundle P of the complexified tangent bundle $T^{\mathbb{C}}M$. Kähler structures are special cases of polarizations which intersect their complex conjugates trivially. Much work has been done discussing how Kähler structures behave under symplectic reduction, with only partial results for the reduction of more general polarizations. In this talk I will discuss the reduction of polarizations and also extend to the setting of singular reduction explored by Sjamaar-Lerman.

CARLO SCARPA, UQAM
[Saturday December 2 / samedi 2 décembre, 16:30 – Symphonie 2B]
The Einstein-Hilbert functional and K-stability

Given a polarised manifold $L \to X$, we explain how K-stability of (X, L) is related to properties of (a version of) the Einstein-Hilbert functional of the circle bundle associated to $L \to X$. This strongly hints at a possible connection between the Yau-Tian-Donaldson conjecture and the Yamabe problem ; to exemplify how this point of view can be useful to understand the geometry of polarised manifolds, we will show a new proof of K-semistability of polarised manifolds admitting constant scalar curvature Kähler metrics. Based on arXiv:2310.11625, joint work with Abdellah Lahdili and Eveline Legendre.

SASHA ZOTINE, Queen's University
[Saturday December 2 / samedi 2 décembre, 17:00 – Symphonie 2B]
Kawaguchi-Silverman Conjecture for Projective Bundles on Curves

The Kawaguchi-Silverman Conjecture (KSC) is a recent conjecture equating two invariants of a dominant rational map between projective varieties: the first dynamical degree and arithmetic degree. The first dynamical degree measures the topological mixing of the map, and the arithmetic degree measures how complicated rational points become after iteration. Recently, the conjecture

was established for several classes of varieties, including projective bundles over any non-elliptic curve. Together with Brett Nasserden (Western Ontario), I resolve the elliptic case, hence proving KSC for all projective bundles over curves.

Automorphic representations and p-adic aspects of the Langlands program
Représentations automorphes et aspects p-adiques du programme de Langlands

Org: Mathilde Gerbelli-Gauthier (McGill University) and/et **Gilbert Moss** (University of Maine)

Automorphic forms are a central object of study in modern number theory. Born of classical questions surrounding quadratic forms in 1960's, their theory has evolved to reveal interrelations between algebraic geometry, representation theory, and complex analysis. The connections between L-functions of automorphic forms and Galois representations are the subject of the rapidly-evolving Langlands program, encompassing many deep theorems and open conjectures. This session will focus on new tools being developed in both the global and local settings, with the aim of bringing together researchers from across Canada and showcasing the contributions of early-career mathematicians.

Schedule/Horaire **Room/Salle: UQAM - PK-2205**

Saturday December 2 — samedi 2 décembre

9:00 - 9:30	Romain Branchereau (McGill), *Toroidal integrals of Kudla-Millson forms and diagonal restrictions of Hilbert modular forms* (p. 69)
9:30 - 10:00	Erman Isik, *On anticyclotomic Iwasawa theory of Hecke characters for ordinary primes* (p. 70)
10:00 - 10:30	Paul Mezo (Carleton), *Arthur packets for real unitary groups* (p. 71)
15:00 - 15:30	Mishty Ray (Calgary), *Vogan's conjecture for p-adic GL_n* (p. 71)
15:30 - 16:00	Henry Kim (Toronto), *Distribution of Hecke eigenvalues for holomorphic Siegel modular forms* (p. 71)
16:00 - 16:30	Martí Roset Julià (McGill), *Dihedral long root local A-packets of G_2 via theta correspondence* (p. 70)
16:30 - 17:00	Giovanni Rosso (Concordia), *Hirzebruch–Zagier cycles in p-adic families and adjoint L-values* (p. 71)
17:00 - 17:30	Ting-Han Huang (Concordia), *Special values of triple product p-adic L-functions and p-adic Abel-Jacobi maps* (p. 70)
17:30 - 18:00	Monica Nevins (Ottawa), *Semisimple characters of fixed-point subgroups* (p. 71)

Sunday December 3 — dimanche 3 décembre

9:00 - 9:30	James Steele (Calgary), *Koszul duality phenomenon in the p-adic local Langlands* (p. 72)
9:30 - 10:00	Ekta Tiwari (Ottawa), *Irreducible supercuspidals of unramified $U(1,1)$* (p. 72)
10:00 - 10:30	Patrick Allen (McGill), *Minimal R = T in the absence of minimal lifts* (p. 69)

Abstracts/Résumés

PATRICK ALLEN, McGill University
[Sunday December 3 / dimanche 3 décembre, 10:00 – UQAM - PK-2205]
Minimal R = T in the absence of minimal lifts

Wiles's famous theorem that all semistable elliptic curves over the rationals are modular follows from R = T theorems, which identify certain parameter rings for Galois representations with Hecke algebras. These R = T theorems are first proved in the so-called minimal case, by Taylor and Wiles, and this is used as an input for the general case. Necessary for the minimal case is the existence of minimal lifts of mod p modular forms, which follows from work of Carayol and Ribet, except for some particular cases that are excluded by the technical Taylor-Wiles hypothesis. We'll consider one of these excluded case and what one can say about minimal R = T theorems for this example, attempting to explain a link between some derived structure on the Galois side with the orbifold structure on the modular side. This is joint work in progress with Preston Wake.

Automorphic representations and p-adic aspects of the Langlands program
Représentations automorphes et aspects p-adiques du programme de Langlands

ROMAIN BRANCHEREAU, McGill
[Saturday December 2 / samedi 2 décembre, 9:00 – UQAM - PK-2205]
Toroidal integrals of Kudla-Millson forms and diagonal restrictions of Hilbert modular forms

Let Y be the locally symmetric spaces of an orthogonal group of signature (p, q). It is a Riemannian manifold of dimension pq and examples of such spaces include modular curves, Hilbert modular surfaces, Bianchi manifolds or more generally hyperbolic manifolds. The Kudla-Millson theta serie Θ_{KM} is a closed differential q-form on Y valued in a space of modular forms of weight $\frac{p+q}{2}$. By integrating this form on q-cycles in Y, it realizes a theta correspondence between the homology $H_q(Y)$ and this space of modular forms, often referred to as the *Kudla-Millson theta lift*. One of its most interesting features is that the Fourier coefficients of this lift can be expressed in terms of certain intersections numbers in Y

A very natural family of cycles is obtained by attaching a cycle $C_{\mathbf{T}}$ in $H_q(Y)$ to an algebraic tori $\mathbf{T}$ of the orthogonal group. In this talk, I will discuss the Kudla-Millson theta lift of such cycles, and in particular explain how the image of $C_{\mathbf{T}}$ is the diagonal restriction of a Hilbert modular forms of parallel weight one for $\mathrm{SL}_2(F_{\mathbf{T}})$, where $F_{\mathbf{T}}$ is a totally real étale algebra attached to $\mathbf{T}$. In the case of signature $(2, 2)$, one can recover a result of Darmon-Pozzi-Vonk about the diagonal restriction of Eisenstein series, as well as a *trace identity* due to Darmon-Harris-Rotger-Venkatesh.

TING-HAN HUANG, Concordia University
[Saturday December 2 / samedi 2 décembre, 17:00 – UQAM - PK-2205]
Special values of triple product p-adic L-functions and p-adic Abel-Jacobi maps

In 2013, H. Darmon and V. Rotger proved a so-called p-adic Gross-Zagier formula, which relates the value of the triple product p-adic L-function attached to Hida families at a balanced classical triple, to the image of the generalized diagonal cycle under the p-adic Abel-Jacobi map, evaluated at a certain differential. In this talk, I will present a generalization of their result to finite slope families. We first introduce the construction of the triple product p-adic L-function by F. Andreatta and A. Iovita. Then we explain the Abel-Jacobi map, the explicit computation of which involves A. Besser's finite polynomial cohomology theory. In the end, we will show how to relate the two objects, and hence prove the p-adic Gross-Zagier formula. If time permits, we will also mention how the formula contributes to the equivariant BSD conjecture.

ERMAN ISIK, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 9:30 – UQAM - PK-2205]
On anticyclotomic Iwasawa theory of Hecke characters for ordinary primes

Iwasawa theory is an area of Number Theory that was named after the fundamental work of Kenkichi Iwasawa in the late 1950s and onward. Classically, it is concerned with the growth of arithmetically interesting objects, such as class groups, Mordell-Weil and Tate-Shafarevich groups, or more generally Selmer groups, in $\mathbb{Z}_p$-power-extensions of a number field (or in modern days, any p-adic families, such as the ones constructed by Hida and Coleman).

In this talk, I will first introduce Nekovar's theory of Selmer complexes, which allows us to study the Selmer groups in the framework of derived categories. We then explore a consequence towards the anticyclotomic Iwasawa main conjecture for CM Hilbert modular forms using Nekovar's descent formalism of Selmer complexes (as a generalization of the main results of Agboola - Howard and T. Arnold on CM elliptic curves and self-dual CM modular forms, respectively).

MARTÍ ROSET JULIÀ, McGill University
[Saturday December 2 / samedi 2 décembre, 16:00 – UQAM - PK-2205]
Dihedral long root local A-packets of G_2 via theta correspondence

Let G be a split exceptional group of type G_2. Arthur's Conjecture describes the constituents of the square integrable automorphic representations of G. It decomposes this space as a direct sum of subspaces consisting of near equivalence classes of representations. These subspaces, called A-packets, are indexed by certain morphisms called A-parameters.

Automorphic representations and p-adic aspects of the Langlands program
Représentations automorphes et aspects p-adiques du programme de Langlands

We will focus on the so-called dihedral long root A-parameters of G. We will explain that they factor through A-parameters for $\mathrm{PU}_3 \rtimes \mathbb{Z}/2\mathbb{Z}$. Motivated by this, we will use the exceptional theta correspondence between $\mathrm{PU}_3 \rtimes \mathbb{Z}/2\mathbb{Z}$ and G to propose a construction of the local representations of G that appear in the corresponding A-packets. This is joint work with Raúl Alonso, Qiao He, and Mishty Ray and is part of a larger project (involving other authors) that aims to prove Arthur's Conjecture for this type of A-parameters.

HENRY KIM, University of Toronto
[Saturday December 2 / samedi 2 décembre, 15:30 – UQAM - PK-2205]
Distribution of Hecke eigenvalues for holomorphic Siegel modular forms

We present two results on the distribution of Hecke eigenvalues of holomorphic Siegel modular forms. The first is the average Sato-Tate distribution, and the second is the Gaussian central limit theorem. The main tool is the vertical Sato-Tate theorem proved using Arthur's invariant trace formula. This is a joint work with S. Wakatsuki and T. Yamauchi.

PAUL MEZO, Carleton University
[Saturday December 2 / samedi 2 décembre, 10:00 – UQAM - PK-2205]
Arthur packets for real unitary groups

Mok, Moeglin and Renard have defined Arthur packets for unitary groups. Their definition follows Arthur's work on classical groups, and relies on harmonic analysis. For real groups an alternative definition of Arthur packets has been known since the early 90s. This approach, due to Adams-Barbasch-Vogan, relies on sheaf-theoretic techniques instead of harmonic analysis. In joint work with N. Arancibia, we prove that these two definitions are equivalent for real unitary groups.

MONICA NEVINS, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 17:30 – UQAM - PK-2205]
Semisimple characters of fixed-point subgroups

Let G be a connected reductive group over a local nonarchimedean field of residual characteristic p and set $H = (G^\Gamma)^\circ$, where $\Gamma \subset Aut(G)$ is a finite group such that $\gcd(p, |\Gamma|) = 1$. The restriction of an Adler-Yu type (J, λ) to its pro-p radical is called a semisimple character in the setting of Bushnell-Kutzko-Stevens types. In this talk we show that the restriction of any Γ-stable datum defining a semisimple character for G gives that of a semisimple character for H and that all semisimple characters for H arise in this way. This offers new examples of endo-equivalence (as introduced by Bushnell-Henniart) with interpretations in the local Langlands correspondence. Part of this is joint work with Peter Latham.

MISHTY RAY, University of Calgary
[Saturday December 2 / samedi 2 décembre, 15:00 – UQAM - PK-2205]
Vogan's conjecture for p-adic GL_n

ABV-packets are proposed generalizations of local Arthur packets and this notion was developed for p-adic groups following the geometric perspective of Adams, Barbasch, and Vogan. When considering groups over p-adic fields, we call this Vogan's conjecture. In this talk, we discuss the proof of Vogan's conjecture for GL_n over a p-adic field. This is joint work with Clifton Cunningham.

GIOVANNI ROSSO, Concordia
[Saturday December 2 / samedi 2 décembre, 16:30 – UQAM - PK-2205]
Hirzebruch–Zagier cycles in p-adic families and adjoint L-values

Automorphic representations and p-adic aspects of the Langlands program
Représentations automorphes et aspects p-adiques du programme de Langlands

Let E/F be a quadratic extension of totally real fields. The embedding of the Hilbert modular variety of F inside the Hilbert modular variety of E defines a cycle, called Hirzebruch–Zagier cycle. Thanks to work of Hida and Getz–Goresky, it is known that the integral of a Hilbert modular form g for E over this cycle detects if g is the base change of a Hilbert modular form for f, and in this case the value of the integral is related to the adjoint L-function of f. In this talk we shall present joint work with Antonio Cauchi and Marc-Hubert Nicole, where we show that the Hirzebruch–Zagier cycles vary in families when one considers deeper and deeper levels at p. We shall present applications to Λ-adic Hilbert modular forms and adjoint p-adic L-functions.

JAMES STEELE, University of Calgary
[Sunday December 3 / dimanche 3 décembre, 9:00 – UQAM - PK-2205]
Koszul duality phenomenon in the p-adic local Langlands

In the 90s, David Vogan showed that the local Langlands correspondence for a connected, reductive, p-adic group G can be reformulated as a bijection between the irreducible representations of G, and its pure inner forms, and the simple objects of a category of equivariant perverse sheaves on a moduli space of Langlands parameters. In the case of generalised Steinberg representations for semisimple G, we show that this correspondence can be interpreted through the language of Koszul duality, and that a number of the categorical aspects of either side of the correspondence are reflected through this duality.

EKTA TIWARI, University of Ottawa
[Sunday December 3 / dimanche 3 décembre, 9:30 – UQAM - PK-2205]
Irreducible supercuspidals of unramified $U(1,1)$

In this talk, I will give a brief summary about how to construct supercuspidal representations of unramified $U(1,1)$ and explain the branching rules for certain cases.

Cluster Algebras in Representation Theory
Les groupes d'algèbres dans la théorie des représentations

Org: Elie Casbi (Northeastern University), **Sabin Cautis** (University of British Columbia), **Anne Dranowski** (University of Southern California) and/et **Iva Halacheva** (Northeastern University)

Cluster algebras were introduced in 2000 by Fomin and Zelevinsky as a tool for studying canonical bases and positivity for semisimple Lie groups. They have since found applications in myriads of settings such as tropical calculus, Poisson geometry, categorification, geometric Langlands, differential equations, quantum field theory and mirror symmetry. Modern constructions often employ non-commutative geometry (e.g. Poisson geometry of cluster varieties, character formulae from quiver Grassmannians) and higher algebra (e.g. module categories for quiver Hecke algebras, affine quantum groups, the coherent Satake category) to tackle questions originally formulated in the language of cluster algebras. These frameworks provide powerful tools for investigating rich combinatorics (e.g. hook length formulae, webs, polytopes) and math physics phenomena (e.g. scattering amplitudes, wall-crossing). They also seldom communicate. One of the main objectives of the proposed session is therefore to facilitate a diverse group of researchers to share their unique perspectives by presenting their own recent cluster-theoretic advances in an accessible way. Significant open problems our session hopes to shed light on include:

• When does a representation theoretic canonical basis contain the cluster monomials ? • To what extent does tropical geometry control cluster structure ? • Can representation theory explain the appearance of cluster structure in math physics ?

Schedule/Horaire — Room/Salle: Inspiration Room

Saturday December 2 — samedi 2 décembre

9:00 - 9:30	Joel Kamnitzer (McGill), *Cluster algebras, MV polytopes, and MV cycles* (p. 74)
9:30 - 10:00	Tom Gannon (UCLA), *Proof of the Ginzburg-Kazhdan conjecture* (p. 73)
10:00 - 10:30	Kayla Wright (UMN), *Higher Dimers, Webs and Grassmannian Cluster Algebras* (p. 76)
15:00 - 15:30	Karen Yeats (Waterloo), *T-duality by Le diagrams* (p. 76)
15:30 - 16:00	Yu Li (Toronto), *Integrable systems on the dual of nilpotent Lie subalgebras and T-Poisson cluster structures* (p. 74)
16:00 - 16:30	Theo Pinet (Institut de Mathématiques de Jussieu-Paris Rive Gauche), *Inflations for representations of shifted quantum affine algebras* (p. 75)
16:30 - 17:00	Milen Yakimov (Northeastern), *Finite generation and representation theory of quantum cluster algebras at roots of unity* (p. 76)
17:00 - 17:30	James Hughes (Duke), *Cluster Modular Groups of Braid Varieties* (p. 74)

Sunday December 3 — dimanche 3 décembre

8:30 - 9:00	Dinushi Munasinghe (Toronto), *Schur Algebras in Type B* (p. 75)
9:00 - 9:30	Gordana Todorov (Northeastern), *Higher Auslander Algebras and Fundamental Domains of Cluster Categories* (p. 75)
9:30 - 10:00	Hugh Thomas (UQAM), *Generalized associahedra as moment polytopes* (p. 75)
10:00 - 10:30	Alexis Leroux Lapierre (McGill), *An algebraic equivariant multiplicity using limits of characters* (p. 74)

Abstracts/Résumés

TOM GANNON, UCLA

[Saturday December 2 / samedi 2 décembre, 9:30 – Inspiration Room]

Proof of the Ginzburg-Kazhdan conjecture

Cluster Algebras in Representation Theory
Les groupes d'algèbres dans la théorie des représentations

The main theorem of this talk will be that the affine closure of the cotangent bundle of the basic affine space (also known as the universal hyperkahler implosion) has symplectic singularities for any reductive group, where essentially all of these terms will be defined in the course of the talk. After discussing some motivation for the theory of symplectic singularities, we will survey some of the basic facts that are known about the universal hyperkahler implosion and discuss how they are used to prove the main theorem. Time permitting, we will also discuss recent work in progress, joint with Harold Williams, which identifies the universal hyperkahler implosion in type A with a Coulomb branch in the sense of Braverman, Finkelberg, and Nakajima, confirming a conjectural description of Dancer, Hanany, and Kirwan.

JAMES HUGHES, Duke University
[Saturday December 2 / samedi 2 décembre, 17:00 – Inspiration Room]
Cluster Modular Groups of Braid Varieties

Braid varieties are a family of cluster varieties that arise naturally from the study of Legendrian links and their exact Lagrangian fillings. They encompass several known families of cluster varieties, including positroid varieties, double Bott-Samelson varieties, and open Richardson varieties. The symplectic-geometric origins of braid varieties lead to a combinatorial interpretation of clusters as weaves – colored graphs satisfying certain properties. In this talk I will discuss how to use these combinatorics to describe cluster modular groups in various known and conjectural cases, including in the case of Grassmannians and some of their foldings.

JOEL KAMNITZER, McGill University
[Saturday December 2 / samedi 2 décembre, 9:00 – Inspiration Room]
Cluster algebras, MV polytopes, and MV cycles

I will present some combinatorial observations concerning the relationship between the cluster algebra structure on the coordinate ring of unipotent subgroup and Mirkovic-Vilonen polytopes. Then I will give some speculation on the relationship between this cluster algebra and the theory of MV cycles.

ALEXIS LEROUX LAPIERRE, McGill
[Sunday December 3 / dimanche 3 décembre, 10:00 – Inspiration Room]
An algebraic equivariant multiplicity using limits of characters

The seemingly elementary question of writing down perfect bases for the irreducible representations of semisimple Lie algebras is a problem which finds its source in surprisingly involved mathematical tools. Two such sources are a version of the geometric Satake equivalence (giving rise to the so-called Mirkovic-Vilonen bases) and a categorification of U_q^- using KLR algebras (giving rise to the so-called dual canonical bases). It has been shown that these two families of bases do not coincide, raising the question of understanding the change of basis matrix. To bridge these two different constructions, we introduce a new notion of an algebraic equivariant multiplicity for modules over truncated shifted Yangians through limits of characters. We relate it to some well-studied functions on modules over KLR algebras and to the usual notion of equivariant multiplicity of MV cycles. This is joint work with Anne Dranowski and Joel Kamnitzer.

YU LI, University of Toronto
[Saturday December 2 / samedi 2 décembre, 15:30 – Inspiration Room]
Integrable systems on the dual of nilpotent Lie subalgebras and T-Poisson cluster structures

Let $\mathfrak{g}$ be a semisimple Lie algebra and $\mathfrak{g} = \mathfrak{n} \oplus \mathfrak{h} \oplus \mathfrak{n}_-$ a triangular decomposition. Motivated by a construction of Kostant-Lipsman-Wolf, we construct an integrable system on the dual space of $\mathfrak{n}_-$ equipped with the Kirillov-Kostant Poisson structure. The Bott-Samelson coordinates on the open Bruhat cell (equipped with the standard Poisson structure) makes it into a symmetric Poisson CGL extension, hence giving rise to a T-Poisson cluster structure on it. Our integrable system is obtained

from the initial cluster by taking the lowest degree terms of the initial cluster variables. We conjecture that mutation of clusters gives rise to mutation of integrable systems. This is joint work in progress with Yanpeng Li and Jiang-Hua Lu.

DINUSHI MUNASINGHE, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 8:30 – Inspiration Room]
Schur Algebras in Type B

In type A, the q-Schur algebra of Dipper and James forms a graded cellular quasi-hereditary cover of the Hecke algebra as the commutant via Jimbo's quantum Schur–Weyl duality. In type B, however, the commutant $\mathcal{L}^n(m)$ and the quasi-hereditary cover $\mathcal{S}^n(\Lambda)$ (the cyclotomic q-Schur algebra of Dipper, James and Mathas) are non-isomorphic. At generic parameters they are both Morita equivalent to the type B Hecke algebra, but this fails at special parameters. By realizing $\mathcal{L}^n(m)$ as an idempotent truncation of $\mathcal{S}^n(\Lambda)$ we leverage the well-known structure of the cyclotomic q-Schur algebra to investigate the representation theory of $\mathcal{L}^n(m)$.

THEO PINET, Université Paris Cité and Université de Montréal
[Saturday December 2 / samedi 2 décembre, 16:00 – Inspiration Room]
Inflations for representations of shifted quantum affine algebras

It is well-known that the only finite-dimensional simple Lie algebra admitting a 2-dimensional irreducible representation is $\mathfrak{sl}_2$. The restriction functors appearing in classical Lie theory are therefore not dense on simple modules. The goal of this talk is to show that this density property is however satisfied in the setting of shifted quantum affine algebras (SQAs for short).

SQAs are infinite-dimensional algebras parametrized by a finite-dimensional simple Lie algebra $\mathfrak{g}$ and a coweight of this Lie algebra. They are of fundamental importance in the modern formulation of representation theory and play an essential role in geometry, in quantum integrable systems and in the study of cluster algebras. Let us fix a SQA and denote it by U. Then, like in classical Lie theory, for any choice of simple root of the Lie algebra $\mathfrak{g}$ underlying U, there is a corresponding subalgebra U' which is isomorphic to a SQA of rank 1 (i.e. whose underlying Lie algebra is $\mathfrak{sl}_2$). A natural question to ask is thus whether or not any simple representation of this subalgebra can be lifted to a simple representation of U. The answer is yes and we can even choose these "lifts" so that the action of another important subalgebra of U (which is almost complementary to U' in some sense) is trivial. These special "lifts" are called *inflations*.

The main result of this talk will be an existence theorem for inflations of representations of rank 1 SQAs. We will also present several potential applications of this theorem.

HUGH THOMAS, UQAM
[Sunday December 3 / dimanche 3 décembre, 9:30 – Inspiration Room]
Generalized associahedra as moment polytopes

Generalized associahedra are a well-studied family of polytopes associated to a finite-type cluster algebra and choice of starting cluster. We show that the generalized associahedra constructed by Padrol, Palu, Pilaud, and Plamondon, building on ideas from Arkani-Hamed, Bai, He, and Yan, can be naturally viewed as moment polytopes for an open patch of the quotient of the $\mathcal{A}$-cluster variety with universal coefficients by its maximal natural torus action. We prove our result by showing that the construction of Padrol, Palu, Pilaud, and Plamondon can be understood on the basis of the way that moment polytopes behave under symplectic reduction.

This is joint work with Michael Gekhtman.

GORDANA TODOROV, Northeastern University
[Sunday December 3 / dimanche 3 décembre, 9:00 – Inspiration Room]
Higher Auslander Algebras and Fundamental Domains of Cluster Categories

Cluster Algebras in Representation Theory
Les groupes d'algèbres dans la théorie des représentations

Endomorphism algebras of the fundamental domains of acyclic m-cluster categories (viewed as full subcategories of the appropriate derived categories) are shown by Emre Sen to be of higher representation finite type in the sense of Iyama. Iyama introduced the notion of higher Auslander algebras and higher representation finite algebras and he described the relation between those, generalizing the well known result of Auslander about the correspondence between Auslander algebras and algebras of finite representation type, up to Morita equivalence.

Auslander algebras are defined as (global dimension A $\leq 2 \leq$ dominant dimension A) and higher k-Auslander algebras are defined as (global dimension A $\leq$ k + 1 $\leq$ dominant dimension A).

KAYLA WRIGHT, University of Minnesota
[Saturday December 2 / samedi 2 décembre, 10:00 – Inspiration Room]
Higher Dimers, Webs and Grassmannian Cluster Algebras

In this talk, we will discuss joint work with Moriah Elkin and Gregg Musiker about a combinatorial model for certain Grassmannian cluster algebras. The Grassmannian of k-planes in $\mathbb{C}^n$, Gr(k, n), has a cluster structure that is not well-understood for $k > 2$. In these algebras, Plücker coordinates Δ_I give us a subset of the cluster variables and have lovely combinatorial descriptions. However, most cluster variables are more complicated expressions in Plücker coordinates and lack such a combinatorial description. In our work, we give a graph theoretic interpretation for the Laurent expansion of cluster variables of low degree in terms of higher dimer models. This work employs SL_k-web combinatorics and we conjecture these webs are the key ingredient to understanding Grassmannian cluster algebras. If time permits, I would like to also pose an open problem I hope to work on relating our dimer combinatorics to the categorification of Grassmannian cluster algebras.

MILEN YAKIMOV, Northeastern University
[Saturday December 2 / samedi 2 décembre, 16:30 – Inspiration Room]
Finite generation and representation theory of quantum cluster algebras at roots of unity

We will address two problems on quantum cluster algebras. The first is about transferring finite generation from classical to quantum cluster algebras and back. We will describe an if and only if result, based on techniques from Cayley-Hamilton algebras. The second problem is about the classification of irreducible representations of quantum cluster algebras at roots of unity. We will describe those of maximal dimension, i.e., the so called Azumaya loci. The talk is based on joint works with Shengnan Huang, Thang Le, Greg Muller, Bach Nguyen and Kurt Trampel.

KAREN YEATS, University of Waterloo
[Saturday December 2 / samedi 2 décembre, 15:00 – Inspiration Room]
T-duality by Le diagrams

Lukowiski, Parisi, and Williams gave a combinatorial version of the T-duality map of string theory in terms of decorated permutations. I will explain how to see this map at the level of Le diagrams, a perspective which makes the dimension relation more transparent. The talk will be combinatorial, and while no cluster algebras will appear directly, hopefully the audience will find interesting connections and synergies. Joint work with Simone Hu.

YAN ZHOU, Northeastern
[Inspiration Room]

Combinatorial Design Theory
Théorie de la conception combinatoire

Org: Andrea Burgess (UNB, Saint John), **David Pike** (Memorial University) and/et **Douglas Stinson** (University of Waterloo & Carleton University)

Combinatorial design theory has a history dating back to the 18th century when Leonhard Euler pondered the existence of orthogonal pairs of Latin squares. This session will showcase recent results in topics such as classical designs, cycle systems, graph decompositions, Latin squares and other aspects of design theory.

Schedule/Horaire **Room/Salle: Soprano C**

Saturday December 2 — samedi 2 décembre

8:30 - 9:00	Bill Martin (WPI), *Delsarte designs in finite groups* (p. 80)
9:00 - 9:30	Kianoosh Shokri (Ottawa), *Improving upper bounds on the size of some covering arrays of strength 3* (p. 82)
9:30 - 10:00	Guillermo Nunez Ponasso (WPI), *Maximal determinants of matrices with entries in the roots of unity* (p. 81)
10:00 - 10:30	Mateja Sajna (Ottawa), *A recursive construction of solutions to the directed Oberwolfach problem* (p. 81)
15:00 - 15:30	Brett Stevens (Carleton), *Classification and enumeration of single change covering designs* (p. 82)
15:30 - 16:00	Masoomeh Akbari (Ottawa), *The Generalized Honeymoon Oberwolfach Problem with variable small cycle lengths* (p. 77)
16:00 - 16:30	Don Kreher (Michigan Tech), *Divisible and transverse Bussey systems* (p. 79)
16:30 - 17:00	Jehyun Lee (Michigan Tech), *Uniformly resolvable decompositions of $K_v - I$ into 5-stars* (p. 80)
17:00 - 17:30	Melissa Keranen (Michigan Tech), *Decomposition of complete graphs into disconnected unicyclic graphs with six edges* (p. 79)

Sunday December 3 — dimanche 3 décembre

8:30 - 9:00	Lucia Moura (Ottawa), *Cover-free families on hypergraphs* (p. 80)
9:00 - 9:30	Shuxing Li (Delaware), *Balanced Splittable Hadamard Matrices: Constraints and Constructions* (p. 80)
9:30 - 10:00	Caleb Jones (MUN), *Burning Steiner Triple Systems* (p. 79)
10:00 - 10:30	Peter Danziger (TMU), *Colouring Kirkman triple systems* (p. 79)
15:00 - 15:30	Andrea Burgess (UNB), *Equitable colourings of cycle systems* (p. 78)
15:30 - 16:00	Kate Nimegeers (Victoria), *Pseudoku: A Sudoku Adjacency Algebra and Fractional Completion Threshold* (p. 81)
16:00 - 16:30	Doug Stinson (Waterloo), *Circular external difference families, graceful labellings and cyclotomy* (p. 82)
16:30 - 17:00	Amin Bahmanian (Illinois State), *Toward a Three-dimensional Counterpart of Cruse's Theorem* (p. 78)
17:00 - 17:30	Amanda Chafee (Carleton), *Conditions for a Block Intersection Graph (BIG) of Packings and Coverings to be Hamiltonian & their Relationship to DCCD* (p. 78)

Abstracts/Résumés

MASOOMEH AKBARI, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 15:30 – Soprano C]
The Generalized Honeymoon Oberwolfach Problem with variable small cycle lengths

Combinatorial Design Theory
Théorie de la conception combinatoire

The Honeymoon Oberwolfach Problem (HOP), introduced by Šajna, is one of the most recent variants of the classic Oberwolfach Problem. This problem asks whether it is possible to seat $2m_1 + 2m_2 + \ldots + 2m_t = 2n$ participants consisting of n newlywed couples at t round tables of sizes $2m_1, 2m_2, \ldots, 2m_t$ for $2n-2$ successive nights so that each participant sits next to their spouse every time and next to each other participant exactly once. HOP has been studied by Jerade, Lepine and Šajna, and some significant cases of it have been solved.

We generalize HOP by allowing tables of size two, instead of a minimum size of four as previously defined in HOP. Thus, in the generalized HOP, we are aiming to seat the $2n$ participants at s tables of size 2 and t round tables of sizes $2m_1, 2m_2, \ldots, 2m_t$ with the assumption that $2n = 2s + 2m_1 + 2m_2 + \ldots + 2m_t$. In this talk, we will present a general approach to this problem, and we will show that the generalized HOP has a solution whenever $m_1 + m_2 + \ldots + m_t \leq 10$, that is, the sum of the table sizes other than size 2 is at most 20.

AMIN BAHMANIAN, Illinois State University
[Sunday December 3 / dimanche 3 décembre, 16:30 – Soprano C]
Toward a Three-dimensional Counterpart of Cruse's Theorem

Completing partial latin squares is NP-complete. Motivated by Ryser's theorem for latin rectangles, in 1974, Cruse found conditions that ensure a partial symmetric latin square of order m can be embedded in a symmetric latin square of order n. Loosely speaking, this results asserts that an n-coloring of the edges of the complete m-vertex graph K_m can be embedded in a one-factorization of K_n if and only if n is even and the number of edges of each color is at least $m-n/2$. We establish necessary and sufficient conditions under which an edge-coloring of the complete λ-fold m-vertex 3-graph λK_m^3 can be embedded in a one-factorization of λK_n^3. In particular, we prove the first known Ryser type theorem for hypergraphs by showing that if $n \equiv 0 \pmod 3$, any edge-coloring of λK_m^3 where the number of triples of each color is at least $m/2 - n/6$, can be embedded in a one-factorization of λK_n^3. Finally we prove an Evans type result by showing that if $n \equiv 0 \pmod 3$ and $n \geq 3m$, then any q-coloring of the edges of any $F \subseteq \lambda K_m^3$ can be embedded in a one-factorization of λK_n^3 as long as $q \leq \lambda\binom{n-1}{2} - \lambda\binom{m}{3}/\lfloor m/3 \rfloor$.

These results can be restated as results on embedding partial symmetric layer-rainbow latin cubes in partial symmetric layer-rainbow latin cubes where all diagonal entries are empty.

ANDREA BURGESS, University of New Brunswick Saint John
[Sunday December 3 / dimanche 3 décembre, 15:00 – Soprano C]
Equitable colourings of cycle systems

A c-*colouring* of a design is an assignment of c colours to its points. We call such a colouring *equitable* if in each block, the number of points of any two given colours differ by at most one; that is, in each block, all colours appear as closely as possible to an equal number of times.

Equitable colourings of cycle systems were introduced in work by Adams, Bryant, Lefevre and Waterhouse, who considered equitably 2- and 3-colourable ℓ-cycle systems of K_v and $K_v - I$ for $\ell \in \{4, 5, 6\}$. In this talk, we discuss some constructions of equitably 2-colourable ℓ-cycle decompositions of K_v and $K_v - I$ in the case that v and ℓ have the same parity. In particular, we show that there is an equitably 2-colourable ℓ-cycle system of K_v whenever ℓ is odd and $v \equiv 1$ or $\ell \pmod{2\ell}$.

This is joint work with Francesca Merola.

AMANDA CHAFEE, Carleton University
[Sunday December 3 / dimanche 3 décembre, 17:00 – Soprano C]
Conditions for a Block Intersection Graph (BIG) of Packings and Coverings to be Hamiltonian & their Relationship to DCCD

A double change covering design (DCCD) is a sequence of b k-sets, called blocks, of a V-set in which exactly two elements differ between consecutive blocks and every pair of elements in V is in some block.

We determine sufficient conditions for the block intersection graph (BIG) of block size k packings and block size 3 coverings to be Hamiltonian. The BIG of a packing is Hamiltonian for k even if $4[|X||V\backslash X| - \partial(X)] \geq vk$ and for k odd if $4k[|X||V\backslash X| -$

$\partial(X) \geq v(k^2-1)$. The BIG of a covering is Hamiltonian if $v \geq 3$. Because of our interest in DCCD, we are also interested in Hamiltonian cycles in 1-BIG of block size 3 coverings and we discuss our progress in this case.

PETER DANZIGER, Toronto Metropolitan University
[Sunday December 3 / dimanche 3 décembre, 10:00 – Soprano C]
Colouring Kirkman triple systems

A weak δ-colouring of a block design is an assignment of δ colours to the point set so that no block is monochromatic. The *weak chromatic number* $\chi(S)$ of a block design S is the smallest integer δ such that S has a weak δ-colouring. It has previously been shown that any Steiner Triple System has weak chromatic number at least 3 and that for each $v \equiv 1$ or $3 \pmod 6$ there exists a Steiner triple system on v points that has weak chromatic number 3. Moreover, for each integer $\delta \geq 3$ there exist infinitely many Steiner triple systems with weak chromatic number δ.

In this talk we consider colourings of the subclass of Steiner triple systems which are resolvable, namely Kirkman Triple Systems. We show that for each $v \equiv 3 \pmod 6$ there exists a Kirkman Triple System on v points with weak chromatic number 3. We also show that for each integer $\delta \geq 3$, there exist infinitely many Kirkman triple systems with weak chromatic number δ.

CALEB JONES, Memorial University of Newfoundland
[Sunday December 3 / dimanche 3 décembre, 9:30 – Soprano C]
Burning Steiner Triple Systems

We introduce a round-based model much like graph burning which applies to hypergraphs. The rules for this new model are very natural, and generalize the original model of graph burning. A second model called "lazy burning" is also introduced, along with a new parameter, the lazy burning number. We mostly focus on applying these models to Steiner triple systems, as they have a special significance in the context of burning. We obtain a lower bound on the burning number and an upper bound on the lazy burning number of an STS. Some additional interesting results are shown, such as the fact that there are infinitely many STSs with lazy burning number 3. Finally, we consider a "doubling construction" for STSs, and use it to show that for every natural number n there is an STS with lazy burning number n.

MELISSA KERANEN, Michigan Technological University
[Saturday December 2 / samedi 2 décembre, 17:00 – Soprano C]
Decomposition of complete graphs into disconnected unicyclic graphs with six edges

Let G be a disconnected unicyclic graph with six edges. We prove that G decomposes the complete graph K_n if and only if $n \equiv 0, 1, 4$, or $9 \pmod{12}$, with one exception when $n = 9$. In this talk, I will discuss methods used to prove this result. This result, along with other knows results, gives a complete answer as to which complete graphs allow G-decompositions when G is a graph with six edges.

DON KREHER, Michigan Technological University
[Saturday December 2 / samedi 2 décembre, 16:00 – Soprano C]
Divisible and transverse Bussey systems

A set-system of order N is a pair (X, B), where X is N-element set of points and B is a collection of subsets of X called $blocks$.

In 1852, Professor Dr. J. Steiner of Berlin, asked for which number N does there exist a set system containing no pairs that has order N and maximum block size k satisfying

(1) no block properly contains another block, and

(2) for all $t = 2, 3, ..., k-1$ every t-set that does not contain a block is contained in exactly one block of size $(t+1)$.

W.H. Bussey from the University of Minnesota in 1914 constructed the only known solution. His construction provided for each $k \geq 5$ a set-system of order $N = 2^{k-1} - 1$ and maximum block size k that satisfies Steiner's conditions. At the CMS 75th+1 anniversary summer meeting, I presented our investigation on this problem. See:

C.J. Colbourn, D.L. Kreher and P.R.J. Östergård, Bussey systems and Steiner's tactical problem. $Glas.\ Mat.\ Ser.\ III$, web.math.pmf.unizg.hr/glasnik/forthcoming/pGM7100.pdf

Today's discussion will examine what happens when pairs are allowed as blocks. In particular we consider as blocks the edges of the complete multipartite graph $G = K_{n_1,n_2,\ldots,n_r}$ or its complement $\overline{G}$.

JEHYUN LEE, Michigan Technological University
[Saturday December 2 / samedi 2 décembre, 16:30 – Soprano C]
Uniformly resolvable decompositions of $K_v - I$ into 5-stars

We considered existence problem of uniformly resolvable decompositions of K_v into subgraphs such that each resolution class contains only blocks isomorphic to the same graph. In this talk, I will discuss a complete solution for the case in which one resolution class is K_2 and the rest are $K_{1,5}$.

SHUXING LI, University of Delaware
[Sunday December 3 / dimanche 3 décembre, 9:00 – Soprano C]
Balanced Splittable Hadamard Matrices: Constraints and Constructions

The construction and analysis of Hadamard matrices have been a long standing problem in combinatorial design theory. Recently, Kharaghani and Suda introduced balanced splittable Hadamard matrices, a special type of Hadamard matrices with intriguing internal structures. These matrices have natural connections to various combinatorial objects, especially strongly regular graphs. We will outline constraints on the parameters of balanced splittable Hadamard matrices and describe a construction method using elementary abelian 2-groups.

BILL MARTIN, Worcester Polytechnic Institute
[Saturday December 2 / samedi 2 décembre, 8:30 – Soprano C]
Delsarte designs in finite groups

Let G be a finite group with d non-trivial conjugacy classes and let $\{\chi_0, \chi_1, \ldots, \chi_d\}$ be the full set of irreducible characters of G where χ_0 is the trivial character. For $T \subseteq \{1, \ldots, d\}$ a *Delsarte T-design* in G (or, more precisely, in the conjugacy class association scheme of G) is a subset $C \subseteq G$ satisfying $\sum_{x,y \in C} \chi_j\left(xy^{-1}\right) = 0$ for all $j \in T$. A very interesting problem that is wide open in most cases is to characterize the T-designs in some standard family of finite groups and to find the most efficient (i.e., smallest) designs for various choices of T. In 2006, Bruce Sagan and I gave combinatorial characterizations of T-designs in the symmetric groups and showed that the smallest designs are typically much smaller than the smallest subgroups with the T-design property. In a recent preprint, Alena Ernst and Kai-Uwe Schmidt carried out a similar study for finite general linears groups, with rich results and difficult proofs. I aim to survey these results and, as time permits, give a preliminary report on the case of dihedral groups, an ongoing joint project with undergraduate students Benjaminh Brodeur and Sycamore Herlihy.

LUCIA MOURA, University of Ottawa
[Sunday December 3 / dimanche 3 décembre, 8:30 – Soprano C]
Cover-free families on hypergraphs

Cover-free families, also called superimposed codes, are widely studied combinatorial objects used in combinatorial group testing and in many applications in cryptography and communications. A d-CFF(t, n) is a $t \times n$ incidence matrix of a set system where

no set is contained in the union of up to d other sets. Cover-free families are used for solving the non-adaptive group testing problem: find a set of up to d defective items among n items, by testing them in pre-specified groups corresponding to rows of the matrix (tests). The objective is to minimize the number t of tests.

In this talk, we consider cover-free families on hypergraphs, which are generalizations of cover-free families used in applications where the possible sets of defective items are specified by the edges of a hypergraph. The traditional group testing problem is the special case where the edges of the hypergraph are all d-subsets of an n-set. We discuss recent constructions and our ongoing research on this topic.

KATE NIMEGEERS, University of Victoria
[Sunday December 3 / dimanche 3 décembre, 15:30 – Soprano C]
Pseudoku: A Sudoku Adjacency Algebra and Fractional Completion Threshold

We develop a 4-partite graph representation, G_P, for a partial Sudoku, P. The partite sets correspond to the rows, columns, boxes, and symbols of P. The edges represent unfulfilled conditions in P that are necessary for a completed Sudoku. For instance, if a symbol is missing from a row in P then an edge is drawn between those two vertices in G_P. We define a tile to be a 4-vertex subgraph of G_P corresponding to a valid placement of a symbol in P, noting that P can be completed if and only if G_P permits an edge-decomposition into tiles. We then relate the existence of such a decomposition to the existence of a solution to a specific linear system using an edge-tile inclusion matrix. Through an in-depth analysis of this matrix structure, we uncover a Sudoku adjacency algebra. This algebraic framework is constructed from a coherent configuration consisting of equivalence relations among row-column, row-symbol, column-symbol, and box-symbol Sudoku conditions.

The primary result we present is a minimum degree threshold for G_P that allows for a fractional tile-decomposition and therefore implies the existence of a fractional completion of P. The proof employs spectral decomposition, the properties of coherent configurations, and perturbation theory to estimate a generalized inverse for the matrix representation of a partial Sudoku puzzle in order to find a solution for the relaxed linear system. Improving on this result by finding a minimum degree threshold for an exact tile-decomposition is an interesting open question in this research area.

GUILLERMO NUNEZ PONASSO, Worcester Polytechnic Institute
[Saturday December 2 / samedi 2 décembre, 9:30 – Soprano C]
Maximal determinants of matrices with entries in the roots of unity

Hadamard's determinant inequality states that the determinant of a complex matrix M of order n with entries taken from the complex unit circle satisfies $|\det M| \leq n^{n/2}$ — the matrix M meets this bound with equality if and only if $MM^* = nI_n$.

It is well known that when M is real (having ± 1 entries), then $MM^\intercal = nI_n$ implies that $n = 1, 2$ or n is a multiple of 4. Therefore, if we consider the maximal determinant of matrices with entries in the set $\{+1, -1\}$, then Hadamard's bound is not achievable at odd orders, or at orders $n \equiv 2 \pmod 4$ larger than 2. In the literature, one can find improved upper and lower bounds for the determinant of ± 1 matrices — the exact values of the maximal determinant have been determined for small values of n, and through several infinite families of examples.

In this talk, we consider the more general problem of finding the maximal determinant of matrices with entries taken from the set μ_m of m-th roots of unity, for some fixed value of m. We will present new upper and lower bounds for the determinant for a general value of m, and study the ternary case $m = 3$, and quaternary case $m = 4$ in more detail.

The maximality of the determinant sometimes imposes strong regularity conditions that make the matrices be equivalent to certain combinatorial designs. Conversely, constructions making use of designs or finite geometries, often give large values for the determinant. We will pay special attention to such connections.

MATEJA SAJNA, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 10:00 – Soprano C]
A recursive construction of solutions to the directed Oberwolfach problem

Combinatorial Design Theory
Théorie de la conception combinatoire

The celebrated Oberwolfach problem, over 50 years old and in general still open, asks whether n participants at a conference can be seated at k round tables of sizes $m_1, \ldots, m_k$ (where $m_1 + \ldots + m_k = n$) for several meals so that everybody sits next to everybody else exactly once. This problem can be modeled as a decomposition of the complete graph K_n into 2-factors, each consisting of k disjoint cycles of lengths $m_1, \ldots, m_k$.

In the directed version, we are interested in decomposing K_n^*, the complete symmetric digraph of order n, into spanning subdigraphs, each a disjoint union of k directed cycles of lengths $m_1, \ldots, m_k$ (where $m_1 + \ldots + m_k = n$). Such a decomposition models a seating arrangement of n participants at k tables of sizes $m_1, \ldots, m_k$ such that everybody sits *to the right* of everybody else exactly once.

While the Oberwolfach problem for cycles of uniform length was solved decades ago, the solution to the directed version for uniform-length cycles was completed only in 2023, and while many infinite families of cases of the Oberwolfach problem with variable cycle lengths are known to have a solution, very little is known about the directed version with variable cycle lengths. In this talk, we present a recursive construction that generates solutions to many infinite families of cases of the directed Oberwolfach problem with variable cycle lengths. In particular, we obtain an almost-complete solution to the two-table directed Oberwolfach problem.

This is joint work with Suzan Kadri.

KIANOOSH SHOKRI, University of Ottawa

[Saturday December 2 / samedi 2 décembre, 9:00 – Soprano C]

Improving upper bounds on the size of some covering arrays of strength 3

A Covering array CA$(N; t, k, v)$ is an $N \times k$ array over an alphabet with v symbols with the property that for any t arbitrary columns, all t-tuples from the alphabet occurs at least once as a row. The objective is to minimize N, which is the size of the covering array, for given t, k, and v. We employ CA$(2q^3 - 1; 3, q^2 + q + 1, q)$ constructed by Raaphorst, Moura, and Stevens (2014) based on linear feedback shift register (LFSR) sequences in finite fields as the main ingredients of the generalized "Roux-type" constructions. By using various properties of covering arrays constructed by LFSR sequences, we improve the size of some CAs of strength 3 compared to the best-known CAs provided in the online covering array tables maintained by Colbourn. In particular, we construct CA$(2q^3 + (q-2)(2q^2 - q); 3, 2(q^2 + q + 1), q)$, CA$(2q^3 + (q-2)(2q^2 - q) + q^3 - q^2; 3, q(q^2 + q + 1), q)$, CA$(8q^3 - 10q^2 + 4q - 1; 3, q^2(q^2 + q + 1), q)$, and CA$(8q^3 - 10q^2 + 3q; 3, (q^2 - q + 1)(q^2 + q + 1), q)$ for any prime power q, and CA$(8q^3 - 10q^2 + 3q; 3, q^2(q^2 + q + 1), q)$ for even prime power q. This is joint work with Lucia Moura.

BRETT STEVENS, Carleton University

[Saturday December 2 / samedi 2 décembre, 15:00 – Soprano C]

Classification and enumeration of single change covering designs

Single change covering designs were initially studied in 1969 as a means to optimize magnetic tape access to fill core memory. In a series of ten papers from 1993 to 2001 By Constable, McSorley, Phillips, Preece, Van Rees, Wallis, Yucas and Zhang, the spectrum of SCCDs with block size 2 and 3 was completely solved, progress was made for block sizes 4 and higher and the investigation of "circular" SCCD was begun. In 2018 A. Chafee developed the first recursive construction for circular SCCD which prompted the search and enumeration of small ingredient designs. We describe a canonical augmentation search to enumerate SCCD and generalize Phillips' "end-permutation" and "minor variant" classification schemes. We report our findings so far.

DOUG STINSON, University of Waterloo

[Sunday December 3 / dimanche 3 décembre, 16:00 – Soprano C]

Circular external difference families, graceful labellings and cyclotomy

We discuss a variety of external difference families (EDFs), including strong and circular variants. The study of these combinatorial objects is motivated by applications to robust and nonmalleable threshold schemes. However, they are also of intrinsic

interest, apart from applications. In this talk, we mainly discuss mathematical aspects, especially existence and nonexistence, of circular and strong circular EDFs. Two of the interesting construction techniques involve using graceful labellings to construct circular EDFs, and using classical results on cyclotomic numbers to obtain close approximations to (nonexistent) strong circular EDFs.

Commutative Algebra
Algèbre commutative

Org: Sankhaneel Bisui (University of Manitoba), **Thai Thanh Nguyen** (McMaster University) and/et **Adam Van Tuyl** (McMaster University)

Schedule/Horaire **Room/Salle: Maestro**

Saturday December 2 — samedi 2 décembre

8:00 - 8:30	Arvind Kumar (New Mexico State University), *Resurgence of Classical Varieties* (p. 86)
8:30 - 9:00	Shah Roshan-Zamir (University of Nebraska-Lincoln), *Interpolation in the Weighted Projective Space* (p. 87)
9:00 - 9:30	Thiago de Holleben (Dalhousie University), *Rees algebras and Lefschetz properties of squarefree monomial ideals* (p. 85)
9:30 - 10:00	Michael Morrow (University of Kentucky), *Syzygy Computations in OI-Modules* (p. 87)
10:00 - 10:30	Susan Cooper (University of Manitoba), *Resolutions & Powers of Ideals* (p. 85)
15:00 - 15:30	Hasan Mahmood (Dalhousie University), *Mutation of Simplicial Complexes* (p. 87)
15:30 - 16:00	Trung Chau (University of Utah), *Barile-Macchia resolutions for monomial ideals* (p. 85)
16:00 - 16:30	Elena Guardo (University of Catania), *Expecting the unexpected: quantifying the persistence of unexpected hypersurfaces* (p. 86)
16:30 - 17:00	Nasrin Altafi (Queen's University), *The Weak Lefschetz property and the number of generators of equigenerated monomial ideals* (p. 84)
17:00 - 17:30	Sergio Da Silva (Virginia State University), *Cohen-Macaulay Toric Ideals of Graphs and Geometric Vertex Decomposition* (p. 88)
17:30 - 18:00	Ritika Nair (University of Kansas), *An Improved Terai-Yoshida Theorem* (p. 87)

Sunday December 3 — dimanche 3 décembre

8:30 - 9:00	Mike Cummings (McMaster University), *A Gröbner basis for regular nilpotent Hessenberg Schubert cells* (p. 85)
9:00 - 9:30	Kieran Bhaskara (McMaster University), *Regularity and projective dimension of toric ideals of bipartite graphs* (p. 84)
9:30 - 10:00	Iresha Madduwe (Dalhousie University), *Reconstruction Conjecture on Homological Invariants of Cameron Walker Graphs* (p. 86)
10:00 - 10:30	Peilin Li (University of British Columbia), *Building Monomial Ideal with Fixed Betti Number* (p. 86)

Abstracts/Résumés

NASRIN ALTAFI, Queen's University

[Saturday December 2 / samedi 2 décembre, 16:30 – Maestro]

The Weak Lefschetz property and the number of generators of equigenerated monomial ideals

For a polynomial ring R with standard grading over a field k, we say a graded Artinian quotient algebra R/I has the weak Lefschetz property (WLP) if multiplication by a general linear form has maximal rank in every degree. Over a field k of characteristic zero, I will discuss sharp bounds on the number of generators of an equigenerated monomial ideal I for which R/I satisfies the WLP. This is joint work with Samuel Lundqvist.

Commutative Algebra
Algèbre commutative

KIERAN BHASKARA, McMaster University
[Sunday December 3 / dimanche 3 décembre, 9:00 – Maestro]
Regularity and projective dimension of toric ideals of bipartite graphs

The regularity and projective dimension of combinatorially-defined ideals are frequently-studied invariants in combinatorial commutative algebra. In particular, much work has been done towards understanding the values these invariants can achieve for toric ideals I_G associated with a graph G. In this talk, we fully describe the possible values of these invariants for I_G as G ranges over all bipartite graphs on a fixed number of vertices. As a corollary, we show that any pair of positive integers can be realized as the regularity and projective dimension of a toric ideal of a bipartite graph. Finally, we demonstrate how our main result allows us to completely determine the values all five major invariants studied in the literature for this family of graphs.

TRUNG CHAU, University of Utah
[Saturday December 2 / samedi 2 décembre, 15:30 – Maestro]
Barile-Macchia resolutions for monomial ideals

We develop an algorithm to create homogeneous acyclic matchings for any given monomial ideal. Via discrete Morse theory, they induce cellular resolutions for this ideal, which we call Barile-Macchia resolutions. These resolutions are minimal for edge ideals of weighted oriented forests and (most) cycles. As a result, obtain recursive formulas for graded Betti numbers and projective dimension. Furthermore, we compare Barile-Macchia resolutions to those created by Batzies and Welker and some well-known simplicial resolutions. Under certain assumptions, whenever the above resolutions are minimal, so are Barile-Macchia resolutions.

SUSAN COOPER, University of Manitoba
[Saturday December 2 / samedi 2 décembre, 10:00 – Maestro]
Resolutions & Powers of Ideals

Diana Taylor established a technique to construct a free resolution of an ideal I generated by s monomials using the simplicial chain maps of a simplex on s vertices. Work of Bayer, Peeva and Sturmfels later extended Taylor's work to show that as long as such a simplicial complex satisfies certain homological conditions, it can support a free resolution of I. The idea of using the structure of I to further find data about the Betti numbers of powers of I becomes quite delicate quickly. In this talk we consider a square-free monomial ideal I and describe a complex labeled with the generators of I^r which supports a free resolution of I^r.

MIKE CUMMINGS, McMaster University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Maestro]
A Gröbner basis for regular nilpotent Hessenberg Schubert cells

Hessenberg varieties lie at the intersection of algebraic geometry, combinatorics, and topology. A trend in the last decade has been to study Hessenberg varieties via their local defining ideals, called patch ideals. Recently, Da Silva and Harada showed that in the regular nilpotent case, the patch ideal of the longest word permutation w_0 is a particularly nice complete intersection, which they called a triangular complete intersection.

In this talk, we will define triangular complete intersections and discuss several nice applications, including to Hilbert series and Gröbner bases. We will also show how Da Silva and Harada's w_0-patch results translate to arbitrary patches for the local defining ideals of intersections of regular nilpotent Hessenberg varieties with Schubert cells. This translation preserves triangular complete intersections and we recover Tymoczko's result—in type A—that regular nilpotent Hessenberg varieties are paved by affines.

This is based on work with Sergio Da Silva, Megumi Harada, and Jenna Rajchgot.

Commutative Algebra
Algèbre commutative

THIAGO DE HOLLEBEN, Dalhousie University
[Saturday December 2 / samedi 2 décembre, 9:00 – Maestro]
Rees algebras and Lefschetz properties of squarefree monomial ideals

Many interesting algebraic properties of edge ideals of graphs can be checked by simply verifying whether the underlying graph is bipartite or not. Some examples of this include: the linear type property, the birational property of the rational map the ideal defines, and the equality of symbolic and ordinary powers. From a graph theoretic perspective, a graph (with more edges than vertices) is not bipartite if and only if its incidence matrix has full rank. In this talk, we will see how these equivalences help in the study of Lefschetz properties. We will also see how the study of Lefschetz properties may bring new perspectives into the study of these algebraic properties. In particular, we will see hints of connections between symbolic defects of squarefree monomial ideals and f-vectors of simplicial complexes.

ELENA GUARDO, Università di Catania
[Saturday December 2 / samedi 2 décembre, 16:00 – Maestro]
Expecting the unexpected: quantifying the persistence of unexpected hypersurfaces

Let X be a reduced subscheme in $\mathbb{P}^n$. We say that X admits an unexpected hypersurface of degree d and multiplicity m if the imposition of having multiplicity m at a general point P fails to impose the expected number of conditions on the linear system of hypersurfaces of degree d containing X. We introduce new methods for studying unexpectedness, such as the use of generic initial ideals and partial elimination ideals to clarify when it can and when it cannot occur. We formulate a new way of quantifying unexpectedness (our AV sequence), which allows us detect the extent to which unexpectedness persists as increases but remains constant. We also study how knowledge of the Hilbert function, together with certain geometric assumptions, can provide information about unexpected hypersurfaces.

ARVIND KUMAR, New Mexico State University
[Saturday December 2 / samedi 2 décembre, 8:00 – Maestro]
Resurgence of Classical Varieties

Resurgence number measures the containment behavior of symbolic powers of an ideal into its ordinary powers. However, in general, it does not always resolve the containment problem. In this talk, we will see that resurgence completely resolves the containment problem for classical varieties. This talk will be based on an ongoing work with Vivek Mukundan.

PEILIN LI, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 10:00 – Maestro]
Building Monomial Ideal with Fixed Betti Number

A minimal free resolution of an ideal produces a sequence of integers which are called "Betti numbers." In this talk, I will introduce a constructive method to add generators to a monomial ideal I while preserving most Betti numbers of I. The main method we use to find such monomials is simplicial collapsing from algebraic topology. I will start with an introduction on simplicial collapsing - making a simplicial complex smaller by deleting some faces – and how it interacts with free resolutions of monomial ideals. In my talk, I will show how one can change a monomial ideal, one generator at a time, and keep track of the Betti numbers at the same time using simplicial collapses. Furthermore, with this method, starting with a monomial ideal I, and by a sequence of operations, I will show that we can create infinitely many monomial ideals with arbitrarily many generators that have similar Betti numbers as I. And we can also create infinitely many monomial ideals with the same number generators as I which have exactly the same Betti numbers as I.

Commutative Algebra
Algèbre commutative

IRESHA MADDUWE, Dalhousie University
[Sunday December 3 / dimanche 3 décembre, 9:30 – Maestro]
Reconstruction Conjecture on Homological Invariants of Cameron Walker Graphs

We will discuss that the homological invariants of edge ideals of Cameron Walker graphs, such as regularity, and depth can be reconstructed from its vertex deleted subgraphs. Moreover, we will speak on reconstruction of the lattice points of the edge ideals of Cameron Walker graphs such as $(\mathrm{reg}(R/I), \deg h(R/I))$ and $(\mathrm{depth}(R/I), \dim(R/I))$ using the lattice points of their vertex-deleted subgraphs.

HASAN MAHMOOD, Dalhousie University
[Saturday December 2 / samedi 2 décembre, 15:00 – Maestro]
Mutation of Simplicial Complexes

When a brain processes some information at a certain time, this activity of the brain can be described as a simplicial complex whose vertices are the neurons. This simplicial complex will undergo a change for performing another activity depending on what information is being processed - and the process of changing one simplicial complex to another continues. Let us generalize this phenomenon. Let Δ be a simplicial complex on a finite vertex set V. In theory, there can be many ways of obtaining a simplicial complex from the given one. Let us fix one such way and call it $\mathcal{T}$, which transforms Δ into a new simplicial complex $\mathcal{T}(\Delta)$. Set $\Delta_k = \mathcal{T}(\Delta_{k-1})$ with setting $\Delta_0 = \Delta$. This way we obtain a sequence $\{\Delta_k \ : \ k \in \mathbb{N}\}$ of simplicial complexes. Let us call this sequence a mutation of Δ under $\mathcal{T}$. Since there can only be a finite number of simplicial complexes on V, this mutation would either stabilize, "vanish", or start repeating its terms (up to isomorphism) at some point. In my talk, I will talk about the stability of mutations of some simplicial complexes for a special $\mathcal{T}$ that returns us the Stanley-Reisner complex of the facet ideal for the input simplicial complex.

MICHAEL MORROW, University of Kentucky
[Saturday December 2 / samedi 2 décembre, 9:30 – Maestro]
Syzygy Computations in OI-Modules

Given a sequence of related modules M_n defined over a sequence of related polynomial rings, one may ask how to simultaneously compute the syzygy module of each M_n. Working in the setting of OI-modules over Noetherian polynomial OI-algebras, we present an OI-analogue of Schreyer's theorem for computing syzygies. Here, OI denotes the category of totally ordered finite sets with order-preserving injective maps.

RITIKA NAIR, University of Kansas
[Saturday December 2 / samedi 2 décembre, 17:30 – Maestro]
An Improved Terai-Yoshida Theorem

In 2005, Terai-Yoshida showed that certain class of Stanley-Reisner rings having sufficiently large multiplicities are Cohen-Macaulay. In the joint work with Anton Dochtermann, Jay Schweig, Adam Van Tuyl and Russ Woodroofe, we strengthen their result by showing that simplicial complexes having many facets are vertex decomposable. If time permits, we shall also discuss an alternative proof for the Alexander dual version of the Terai-Yoshida result.

SHAH ROSHAN-ZAMIR, University of Nebraska-Lincoln
[Saturday December 2 / samedi 2 décembre, 8:30 – Maestro]
Interpolation in the Weighted Projective Space

Given a finite set of points X in the projective space over a field k one can ask for the k-vector space dimension of all degree d polynomials that vanish to order two on X. (These are polynomials whose first derivative vanishes on X.) The Alexander-

Hirschowitz theorem (A-H) computes this dimension in terms of the multiplicity of the points and the k-vector space dimension of degree d monomials, with finitely many exceptions. In this talk, we investigate this question in the weighted projective line and space, $\mathbb{P}(s,t)$ and $\mathbb{P}(a,b,c)$. We define a notion of multiplicity for weighted spaces, give an example of $\mathbb{P}(a,b,c)$ where A-H holds with no exceptions and an infinite family where A-H fails for even one point, and discuss future directions.

SERGIO DA SILVA, Virginia State University
[Saturday December 2 / samedi 2 décembre, 17:00 – Maestro]
Cohen-Macaulay Toric Ideals of Graphs and Geometric Vertex Decomposition

Understanding when the toric ideal of a graph defines a Cohen-Macaulay variety remains an open problem which is related to whether the ideal is geometrically vertex decomposable (GVD). Toric ideals of graphs which are GVD are automatically glicci and Cohen-Macaulay, but it can be difficult to check the GVD property directly. Alternate versions of the property, like being weakly GVD or GVD allowing substitution, are easier to check and still imply the Cohen-Macaulay property. I will provide a brief overview of geometric vertex decomposition and how its various formulations can be used to find graphs whose toric ideals are Cohen-Macaulay. I will also provide an update on topics related to the interaction of GVDs with toric ideals of graphs, including graph coloring, Hamiltonian cycles, and the GVD classification problem.

Computational and Geometric Spectral Theory

Org: Alexandre Girouard (Université Laval) and/et **Nilima Nigam** (Simon Fraser University)

The purpose of this session is to bring together researchers from various sub-elds of spectral geometry, including in particular computational methods. Topics welcome include spectral optimization, spectral asymptotics, the geometry of nodal lines and non-standard spectral problems. Spectral geometry is a rapidly evolving subject, which is very well represented in the Canadian mathematical community. Part of this session will play the role of a follow up to previous sessions that were held at CMS meetings in 2015 (Montreal), 2018 (Vancouver), and 2022 (St. John's).

Schedule/Horaire

Saturday December 2 — **samedi 2 décembre**

8:30 - 9:00	Graham Cox (Memorial University), *Geometry and topology of spectral minimal partitions* (p. 90)
9:00 - 9:30	Jade Brisson (Université de Neuchâtel), *Tubes and Steklov eigenvalues in negatively curved manifolds* (p. 90)
9:30 - 10:00	Craig Sutton (Dartmouth) (p. 92)
10:00 - 10:30	Hanna Kim (Illinois), *Upper Bound on the Second Laplacian Eigenvalue on the Real Projective Space* (p. 90)
15:00 - 15:30	Jeff Ovall (Portland State), *Concerning the localization of eigenvectors for the magnetic Laplacian operator* (p. 91)
15:30 - 16:00	Hanna Potgieter (SFU), *Numerical approximation of the first p-Laplace eigenpair for large p values* (p. 91)
16:00 - 16:30	Daniel Venn (SFU), *Surface Partial Differential Equation Solvability and Eigenvalues with Symmetric Meshfree Methods* (p. 92)
16:30 - 17:00	Evans Harrell (GIT), *Upper and lower bounds for eigenvalue gaps for Schrödinger operators and quantum graphs* (p. 90)
17:00 - 17:30	David Sher (De Paul), *Bessel function zeroes and Polya's conjecture* (p. 92)

Sunday December 3 — **dimanche 3 décembre**

8:30 - 9:00	Maxime Fortier Bourque (UDM), *Two counterexamples to a conjecture of Colin de Verdière* (p. 89)
9:00 - 9:30	Alain Didier Noutchegueme (UDM), *Shape Optimisation for Steklov transmission eigenvalues on surfaces* (p. 91)
9:30 - 10:00	Dima Jakobson (McGill), *Nodal sets and negative eigenvalues in conformal geometry* (p. 90)
15:00 - 15:30	Frédéric Rochon (UQAM), *Torsion on some fibered cusp manifolds* (p. 91)
15:30 - 16:00	Vukašin Stojisavljević (Université de Montréal), *Nodal topology and persistence barcodes* (p. 92)
16:00 - 16:30	Denis Vinokurov (Université de Montréal), *The first eigenvalue of the Laplacian on orientable surfaces* (p. 93)
16:30 - 17:00	John Toth (McGill), *Goodness estimates in microlocally allowable regions* (p. 92)

Abstracts/Résumés

MAXIME FORTIER BOURQUE, Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 8:30]
Two counterexamples to a conjecture of Colin de Verdière

Computational and Geometric Spectral Theory

In 1986, Yves Colin de Verdière conjectured that the multiplicity of the first nonzero eigenvalue of the Laplacian on a closed connected Riemannian manifold is bounded by its chromatic number minus one. I will describe two hyperbolic surfaces of genus 10 and 17 that disprove this conjecture. The proof that these surfaces have large multiplicity uses the twisted Selberg trace formula to rule out low-dimensional representations of their isometry group from appearing in the first eigenspace. This is joint work with Émile Gruda-Mediavilla, Bram Petri, and Mathieu Pineault.

JADE BRISSON, Université de Neuchâtel

[Saturday December 2 / samedi 2 décembre, 9:00]

Tubes and Steklov eigenvalues in negatively curved manifolds

In this talk, we establish a tubular neighborhood theorem for embedded closed totally geodesic hypersurfaces in a negatively curved manifolds of dimension $n \geq 3$ extending Basmajian's result in 1994 in the hyperbolic setting. We then consider the Steklov eigenvalue problem on compact pinched negatively curved manifolds with totally geodesic boundaries. We show that the first nonzero Steklov eigenvalue is bounded below in terms of the total volume and boundary area when the dimension is at least three. In particular, it shows that Stelov eigenvalues can only tend to zero when the total volume and/or boundary area go to infinity. It can be seen as a counterpart of the lower bound for the first nonzero Laplace eigenvalues on closed pinched negatively curved manifolds of dimension at least three as proved by Schoen in 1982. We provide examples showing that the dependency on both volume and boundary area is necessary. This is a joint work with Ara Basmajian, Asma Hassannezhad and Antoine Métras.

GRAHAM COX, Memorial University

[Saturday December 2 / samedi 2 décembre, 8:30]

Geometry and topology of spectral minimal partitions

A minimal partition is a decomposition of a manifold into disjoint sets that minimizes a certain energy functional. In the bipartite case minimal partitions are closely related to eigenfunctions of the Laplacian, but in the non-bipartite case they are difficult to classify, even for simple domains like the square or the circle.

I will present new results that say a partition that minimizes energy locally is in fact a global minimum (in the bipartite case) and a minimum within a certain topological class of partitions in the non-bipartite case. I will also explain how to construct energy-decreasing deformations of a non-minimal partition, giving insight into the geometric structure of the true minimum. This is joint work with Gregory Berkolaiko, Yaiza Canzani, Peter Kuchment and Jeremy Marzuola.

EVANS HARRELL, Georgia Tech

[Saturday December 2 / samedi 2 décembre, 16:30]

Upper and lower bounds for eigenvalue gaps for Schrödinger operators and quantum graphs

The fundamental spectral gap is a well-studied object in spectral geometry and quantum theory. I will report on some recent bounds on this quantity for Schrödinger operators on intervals and metric graphs (networks), showing how the size of the gap is affected on the one hand by assumptions on the potential energy such as convexity and on the other by the topological structure of the graph. Differences from the situation with domains will be noted. This work is joint in part with Borthwick and Zhu, and in part with with Ahrami, El Allali, and Kennedy.

DIMA JAKOBSON, McGill

[Sunday December 3 / dimanche 3 décembre, 9:30]

Nodal sets and negative eigenvalues in conformal geometry

I will survey some old and more recent results on conformal invariants that arise from nodal sets of eigenfunctions of the conformal laplacian, discuss applications to Nirenberg type problems as well as some related questions

Computational and Geometric Spectral Theory

HANNA KIM, University of Illinois, at Urbana-Champaign
[Saturday December 2 / samedi 2 décembre, 10:00]
Upper Bound on the Second Laplacian Eigenvalue on the Real Projective Space

In this talk, I prove an upper bound on the second non-zero Laplacian eigenvalue on n-dimensional real projective space. The sharp result for 2-dimension was shown by Nadirashvili and Penskoi and later by Karpukhin when the metric degenerates to that of the disjoint union of a round projective space and a sphere. That conjecture is open in higher dimensions, but I will prove it up to a constant factor that tends to 1 as the dimension tends to infinity. Also, I will also talk about calculating the degree of a map on odd-dimensional spheres with the reflection symmetry property.

ALAIN DIDIER NOUTCHEGUEME, Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 9:00]
Shape Optimisation for Steklov transmission eigenvalues on surfaces

Consider a curve on a closed surface endowed with a Riemannian metric. The Steklov transmission problem is to find continuous functions which are harmonic away from the curve, and such that the jump of the normal derivative across the curve is proportional to the value of the function. Such functions are called Steklov transmission eigenfunctions, and the corresponding proportionality coefficients are called Steklov transmission eigenvalues. We will discuss shape optimisation questions for these eigenvalues, and highlight some similarities and differences compared to the usual Steklov case. The talk is based on a joint work with Mikhail Karpukhin (UCL).

JEFF OVALL, Portland State University
[Saturday December 2 / samedi 2 décembre, 15:00]
Concerning the localization of eigenvectors for the magnetic Laplacian operator

Over the past 15 years, significant progress has been made in the mathematical understanding of the mechanisms driving the spatial localization of eigenvectors for standard Schrödinger-type operators, $-\Delta + V$, with a rich theory developing around the so-called "localization landscape" function. In contrast, relatively little theory has been developed concerning localization phenomena for the magnetic Schrödinger operator, $(i\nabla + \mathbf{A})^2 + V$. We present some of our recent contributions to this topic, focusing on the magnetic Laplacian, $V = 0$, and providing both theoretical and computational results.

HANNA POTGIETER, Simon Fraser University
[Saturday December 2 / samedi 2 décembre, 15:30]
Numerical approximation of the first p-Laplace eigenpair for large p values

We present an alternating direction method of multipliers (ADMM) algorithm for approximating the first eigenpair of the p-Laplace operator with zero Dirichlet boundary conditions. In this talk we will discuss the p $\to \infty$ limit and its connection to the underlying geometry of our domain. Working with large p values presents numerical challenges against which the ADMM algorithm outperforms a Newton based solver, at least in certain cases. We show some preliminary computational results in 1D, planar domains, and surfaces lying in $\mathbb{R}^3$.

FRÉDÉRIC ROCHON, UQAM
[Sunday December 3 / dimanche 3 décembre, 15:00]
Torsion on some fibered cusp manifolds

Given a number field F with ring of integers O_F, one can associate to any torsion free subgroup of $SL(2, O_F)$ of finite index a complete Riemannian manifold of finite volume with fibered cusp ends. For natural choices of flat vector bundles on such a

manifold, we show that analytic torsion is identified with the Reidemeister torsion of the Borel-Serre compactification. This is used to obtain exponential growth of torsion in cohomology for sequences of congruence subgroups. This is an ongoing joint work with Werner Müller.

DAVID SHER, DePaul University
[Saturday December 2 / samedi 2 décembre, 17:00]
Bessel function zeroes and Polya's conjecture

I will discuss some recent results giving uniform bounds for zeroes of Bessel functions and their derivatives. These bounds can be used to analyze the spectrum of the Laplacian on domains with radial symmetry, and in particular, to prove Polya's conjecture for Euclidean balls. This is joint work with N. Filonov (St. Petersburg), M. Levitin (Reading), and I. Polterovich (Montreal).

VUKAŠIN STOJISAVLJEVIĆ, Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 15:30]
Nodal topology and persistence barcodes

Classical Courant's nodal domain theorem, together with Weyl's law, gives an upper bound on the number of nodal domains of a Laplace-Beltrami eigenfunction in terms of the corresponding eigenvalue. In general, bounds of this type can not exist for linear combinations of eigenfunctions. We will show how, by coarsely counting nodal domains, i.e. by discarding small oscillations, we may obtain a similar upper bound for linear combinations as well. Our method combines the theory of persistence modules and barcodes with multiscale polynomial approximation of functions in Sobolev spaces. Using the same method, we may study coarse topology of a zero set of a function, as well as coarse topology of the set of common zeros of a number of different functions. This allows us to prove a coarse version of Bézout's theorem for linear combination of Laplace-Beltrami eigenfunctions. The talk is based on a joint work with L. Buhovsky, J. Payette, I. Polterovich, L. Polterovich and E. Shelukhin.

CRAIG SUTTON, Dartmouth
[Saturday December 2 / samedi 2 décembre, 9:30]

JOHN TOTH, McGill University
[Sunday December 3 / dimanche 3 décembre, 16:30]
Goodness estimates in microlocally allowable regions

Let (M, g) be a compact, C^ω Riemannian surface. Let $\{u_h\}$ be a quantum ergodic (QE) sequence of Laplace eigenfunctions. Then, for every locally asymmetric C^∞ curve $H \subset M$ there exist $C_H > 0$ and $h_0 > 0$ such that for $0 < h < h_0$

$$\|u_h\|_{L^2(H)} \geq e^{-C_H/h}.$$

In particular, such curves do not persist as components of eigenfunction nodal sets. This is joint work with Yaiza Canzani (UNC Chapel Hill).

DANIEL VENN, Simon Fraser University
[Saturday December 2 / samedi 2 décembre, 16:00]
Surface Partial Differential Equation Solvability and Eigenvalues with Symmetric Meshfree Methods

Computational and Geometric Spectral Theory

We present a novel technique and analysis for investigating the solvability of certain linear partial differential equations (PDEs) using underdetermined Fourier extensions or symmetric Hermite radial basis function methods. The technique applies to surface PDEs as well as flat domain problems.

While much recent work has been completed on using meshfree methods for solving a wide range of PDEs, the spectra of operators discretized using radial basis functions (RBFs) suffers from the presence of non-physical eigenvalues (spurious modes). This makes many RBF methods unhelpful for eigenvalue problems. Our technique provides a rigorously justified process for finding eigenvalues based on a result concerning the norm of a Hermite RBF solution in its native space ; specifically, only PDEs with solutions in the native space produce RBF solutions with bounded norms as the fill distance approaches zero.

The approach also works with underdetermined Fourier extensions: our own related approach with certain flexibility and stability advantages. Importantly, both the Fourier extension and Hermite RBF methods for eigenvalues can be used for surface eigenvalue problems. Meshfree methods are desirable for surface problems due to the increased difficulties associated with mesh creation and refinement on curved surfaces.

DENIS VINOKUROV, Université de Montréal

[Sunday December 3 / dimanche 3 décembre, 16:00]

The first eigenvalue of the Laplacian on orientable surfaces

The famous Yang-Yau inequality provides an upper bound for the first eigenvalue of the Laplacian on an orientable Riemannian surface solely in terms of its genus γ and the area. Its proof relies on the existence of holomorhic maps to $\mathbb{CP}^1$ of low degree. Very recently, Ros was able to use certain holomorphic maps to $\mathbb{CP}^2$ in order to give a quantitative improvement of the Yang-Yau inequality for $\gamma = 3$. In the present paper, we generalize Ros' argument to make use of holomorphic maps to $\mathbb{CP}^n$ for any $n > 0$. As an application, we obtain a quantitative improvement of the Yang–Yau inequality for all genera except for $\gamma = 4, 6, 8, 10, 14$. Later, Ros adjusted some parts of the prove that has lead to even better assymptotic estimates.

Current Trends in Matrices, Graphs and Computing
Tendances actuelles dans les matrices, les graphes et l'informatique

Org: Shaun Fallat, **Seyed Ahmad Mojallal** and/et **Sandra Zilles** (University of Regina)

Research on topics involving graphs and matrices is very well established and impacts the areas of algebraic and spectral graph theory, combinatorial analysis in matrix theory, as well as numerous application areas that extend into applied mathematics, physics, and computer science. Specific recent advances and directions include: inverse eigenvalue problem for graphs ; quantum state transfer in graphs, algebraic properties of discrete networks ; and applications within the realm of artificial intelligence, including certain aspects of machine learning. Computations associated with many interesting aspects involving both graphs and matrices have become increasingly vital for future studies at this confluence. The purpose of this session is to gather researchers, both experienced and junior, with expertise in any of these topics to present accounts of their contemporary research, and provide interested participants with proposed trends and concrete problems for future analysis in all of these important and popular research areas.

Schedule/Horaire

Saturday December 2 — **samedi 2 décembre**

8:30 - 9:00	Chris Godsil (University of Waterloo), *Periodicity of Oriented Cayley Graphs* (p. 95)
9:00 - 9:30	Michael Tait (Villinova), *The largest eigenvalue of the normalized distance Laplacian matrix* (p. 99)
9:30 - 10:00	David Kribs (University of Guelph), *Chordal Graphs and Distinguishability of Quantum States* (p. 96)
10:00 - 10:30	Ahmad Mojallal (University of Regina), *Forts, (fractional) zero forcing, and Cartesian products of graphs* (p. 97)
15:00 - 15:30	Hermie Monterde (University of Manitoba), *Quantum walks on join graphs* (p. 97)
15:30 - 16:00	William Martin (WPI), *Four-class Q-bipartite association schemes* (p. 96)
16:00 - 16:30	Anthony Bonato (Toronto Metropolitan University), *How to cool a graph* (p. 95)
16:30 - 17:00	Kamyar Khodamoradi (University of Regina) (p. 96)
17:00 - 17:30	Hamed Hatami (McGill University), *Littlestone dimension and online learnability of partial matrices* (p. 95)
17:30 - 18:00	Farnam Mansouri (University of Waterloo) (p. 96)

Sunday December 3 — **dimanche 3 décembre**

8:00 - 8:30	Todd Mullen (University of Prince Edward Island), *Pay it Backward* (p. 98)
8:30 - 9:00	Jeremie Turcotte (McGill University), *On an induced version of Menger's theorem* (p. 99)
9:00 - 9:30	Joy Morris (University of Lethbridge), *Can we detect (Di)Graphical Regular Representations easily ?* (p. 97)
9:30 - 10:00	Nathan Johnston (Mount Allison University), *Laplacian $\{-1,0,1\}$- and $\{-1,1\}$-diagonalizable graphs* (p. 96)
10:00 - 10:30	Ada Chan (York University), *Quantum isomorphism and Hadamard graphs* (p. 95)
15:00 - 15:30	Gena Hahn (Université de Montréal), *Siblings, twins and self-embedded graphs* (p. 95)
15:30 - 16:00	Manuel Lafond (Universite de Sherbrooke) (p. 96)
16:00 - 16:30	Mahsa N. Shirazi (University of Manitoba), *Uniform hypergraphs and balanced incomplete block designs with r-friendship property* (p. 98)
16:30 - 17:00	Shivaram Pragada (Simon Fraser University), *Subdivision and Adjacency spectra of Graphs* (p. 98)
17:00 - 17:30	Bojan Mohar (Simon Fraser University), *Extremal trees for eigenvalue combinations* (p. 97)
17:30 - 18:00	Ben Seamone (Dawson College), *Defective acyclic colourings of planar graphs* (p. 98)

Abstracts/Résumés

Current Trends in Matrices, Graphs and Computing
Tendances actuelles dans les matrices, les graphes et l'informatique

---

ANTHONY BONATO, Toronto Metropolitan University
[Saturday December 2 / samedi 2 décembre, 16:00]
How to cool a graph

The spread of influence is a major topic in network science, where contagion spreads from vertex-to-vertex by prescribed rules. We consider a new such process called cooling, which spreads in graphs as slowly as possible. Cooling can be thought of as the dual to burning, which is a well-studied topic introduced a decade ago. We survey results on cooling, including bounds and exact values on graph families, and isoperimetric inequalities with applications to grids.

ADA CHAN, York University
[Sunday December 3 / dimanche 3 décembre, 10:00]
Quantum isomorphism and Hadamard graphs

In 2020, Mančinska and Roberson prove that two graphs G and H are quantum isomorphic if and only if, for any planar graph F, the number of graph homomorphisms from F to G is equal to the number of graph homomorphisms from F to H.

In this talk, we discuss the use of their remarkable characterization to show that any two Hadamard graphs of the same order are quantum isomorphic, and the research questions that arise from this result.

This is joint work with Bill Martin.

CHRIS GODSIL, University of Waterloo
[Saturday December 2 / samedi 2 décembre, 8:30]
Periodicity of Oriented Cayley Graphs

Let X be an oriented graph on n vertices. Its adjacency matrix A is skew-symmetric, i.e., if $u, v \in V(X)$ and uv is an arc in X, then $A_{u,v} = 1$ and $A_{v,u} = -1$, and if neither uv nor vu is an arc in X then $A_{u,v} = 0$. As A is skew-symmetric, iA is Hermitian and the matrices

$$U(t) := \exp(-tA), \quad (t \in \mathbb{R}),$$

are orthogonal. It follows that they determine a continuous quantum walk on ther vertices of X. We say a matrix is *flat* if its entries all have the same absolute value. A quantum walk admits *uniform mixing* at time t if $U(t)$ is flat.

If an $n \times n$ unitary matrix is flat, the absolute values of its entries are equal to $1/\sqrt{n}$, and if $U(t)$ is real and flat, then $\sqrt{n}U(t)$ is a real Hadamard matrix. This provides one reason why we are interested in uniform mixing. We have been trying to characterize which oriented Cayley graphs of abelian groups admit uniform mixing. We have proved that if a Cayley graph admits uniform mixing, the matrix-valued function $U(t)$ is periodic, and that this holds if and only if the eigenvalues of A are all integer multiples of $\sqrt{\Delta}$ for some (necessarily negative) square-free integer Δ. We are able to characterize the possible connection sets of these Cayley graphs.

In my talk I will discuss some of these results, and the machinery used to derive them. This is all joint work with Xiaohong Zhang.

GENA HAHN, Universoté de Montréal
[Sunday December 3 / dimanche 3 décembre, 15:00]
Siblings, twins and self-embedded graphs

Two graphs are siblings if one embeds into the other ; twins are non-isomorphic siblings. Each of the siblings is clearly self-embedded. The conjecture (and its variants and generalisations) is that a countable graph has 0, $\aleph_0$, or $2^{\aleph_0}$ twins. An analysis of disconnected self-embedded graphs leads to a positive answer for many graphs. The conjecture has recently been disproved for trees in a long paper but there are many cases where the conjecture is true and many interesting cases open. In this talk we give a brief survey.

Current Trends in Matrices, Graphs and Computing
Tendances actuelles dans les matrices, les graphes et l'informatique

---

HAMED HATAMI, McGill University
[Saturday December 2 / samedi 2 décembre, 17:00]
Littlestone dimension and online learnability of partial matrices

Answering an open problem of Alon, Hanneke, Holzman, and Moran (FOCS'21), we show that there are partial Boolean matrices with finite Littlestone dimensions, but any completion of them to a full matrix has an infinite Littlestone dimension.

This result shows that the online learnability of a partial concept class is not always inherited from the learnability of some "extension" of it to a total concept class.

The proof uses the breakthrough result of Goos and its subsequent improvements that led to almost optimal super-polynomial bounds on the "biclique partition number versus chromatic number" problem of Alon, Saks, and Seymour.

The talk is based on a joint work with Ben Cheung, Pooya Hatami, and Kaave Hosseini.

NATHAN JOHNSTON, Mount Allison University
[Sunday December 3 / dimanche 3 décembre, 9:30]
Laplacian $\{-1, 0, 1\}$- and $\{-1, 1\}$-diagonalizable graphs

A graph is called "Laplacian integral" if the eigenvalues of its Laplacian matrix are all integers. We investigate the subset of these graphs whose Laplacian is furthermore diagonalized by a matrix with entries coming from a fixed set, with particular emphasis on the sets $\{-1, 0, 1\}$ or $\{-1, 1\}$. Such graphs include as special cases the recently-investigated families of "Hadamard-diagonalizable" and "weakly Hadamard-diagonalizable" graphs. As a combinatorial tool to aid in our investigation, we introduce a family of vectors that we call "balanced", which generalize totally balanced partitions, regular sequences, and complete partitions.

KAMYAR KHODAMORADI, University of Regina
[Saturday December 2 / samedi 2 décembre, 16:30]

DAVID KRIBS, University of Guelph
[Saturday December 2 / samedi 2 décembre, 9:30]
Chordal Graphs and Distinguishability of Quantum States

In this talk, I'll discuss a graph and matrix theoretic approach I've developed with collaborators for the problem of distinguishing quantum product states in the fundamental quantum communication framework called local operations and classical communication (LOCC). We have found that chordal graphs are the most important subgraph type when it comes to distinguishability in 'one-way' LOCC, and we have derived a one-way LOCC characterization for chordal graphs that establishes a connection with the theory of matrix completions. I'll discuss our main results and some examples from our most recent work. This talk is based on joint work with Comfort Mintah, Michael Nathanson, Rajesh Pereira.

MANUEL LAFOND, Universite de Sherbrooke
[Sunday December 3 / dimanche 3 décembre, 15:30]

FARNAM MANSOURI, University of Waterloo
[Saturday December 2 / samedi 2 décembre, 17:30]

Current Trends in Matrices, Graphs and Computing
Tendances actuelles dans les matrices, les graphes et l'informatique

---

WILLIAM MARTIN, Worcester Polytechnic Institute
[Saturday December 2 / samedi 2 décembre, 15:30]
Four-class Q-bipartite association schemes

A *(symmetric) association scheme* can be viewed as a real subalgebra $\mathbb{A}$ of an algebra of square matrices over the reals in which every element is symmetric, which is closed under entrywise multiplication $\circ$ and contains both I and J (the matrix of all ones). Let E be a matrix in $\mathbb{A}$ and, for $0 \leq j \leq d = \dim \mathbb{A}$, denote by $E^{\circ j}$ the matrix whose entries are the j^{th} powers of the entries of E. We say the association scheme is Q*-polynomial* (or *co-metric*) with Q*-polynomial generator* E if the linear spans $\mathcal{I}_j = \langle J, E, \ldots, E^{\circ j} \rangle$ form a chain of ideals in $\mathbb{A}$ with $\mathcal{I}_d = \mathbb{A}$. It follows that $\mathbb{A}$ admits a vector space basis $E_0, E_1, \ldots, E_d$ with $E_i E_j = \delta_{i,j} E_i$ where E_i is expressible as a polynomial of degree i applied entrywise to E. In this talk, we focus on the Q*-bipartite* case where $(E_i \circ E_j)E_k = 0$ whenever $i + j + k$ is odd. We specialize Schoenberg's Theorem to this case and apply it to certain families with $d = 4$. The talk is mostly based on joint work with Brian Kodalen.

BOJAN MOHAR, SFU
[Sunday December 3 / dimanche 3 décembre, 17:00]
Extremal trees for eigenvalue combinations

Let $\lambda_1(T) \geq \lambda_2(T) \geq \cdots \geq \lambda_n(T)$ be the eigenvalues of an n-vertex tree T. Trees for which $\lambda_1(T)$ or $\lambda_2(T)$ is largest or smallest possible among all n-vertex trees have been classified. In this talk the speaker will discuss extremal trees for linear combinations $\alpha\lambda_1(T) + \beta\lambda_2(T)$, where $\alpha, \beta \in \mathbb{R}$. This is joint work with Hitesh Kumar, Shivaramakrishna Pragada, and Harmony Zhan.

AHMAD MOJALLAL, University of Regina
[Saturday December 2 / samedi 2 décembre, 10:00]
Forts, (fractional) zero forcing, and Cartesian products of graphs

In this talk, we introduce the (disjoint) fort number, fractional zero forcing number, and fort hypergraph. The hypergraph results on transversals and matchings are applied to the zero forcing number and fort number. These results are used to establish a Vizing-like lower bound for the zero forcing number of a Cartesian product of graphs for certain families of graphs, and a family of graphs achieving this lower bound is exhibited.

HERMIE MONTERDE, University of Manitoba
[Saturday December 2 / samedi 2 décembre, 15:00]
Quantum walks on join graphs

Let M be the adjacency or Laplacian matrix of a graph X. A quantum walk on X is determined by the unitary matrix $U(t) = \exp(itM)$, whereby $|U(t)_{u,v}|^2$ is interpreted as the probability that a quantum state at vertex u is found at vertex v at time t. In particular, if $|U(\tau)_{u,v}|^2 = 1$, then we say that perfect state transfer occurs between u and v at time τ.

The join $X \vee Y$ of two graphs X and Y is the graph obtained by joining each vertex of X to each vertex of Y. In this talk, we discuss the properties of quantum walks on join graphs, with emphasis on perfect state transfer. Throughout, we rely on the spectral properties of join graphs relative to the adjacency and Laplacian matrix.

JOY MORRIS, University of Lethbridge
[Sunday December 3 / dimanche 3 décembre, 9:00]
Can we detect (Di)Graphical Regular Representations easily ?

Graphical and Digraphical Regular Representations (GRRs and DRRs) are a concrete way to visualise the regular action of a

group, using (di)graphs. More precisely, a GRR or DRR on the group G is a (di)graph whose automorphism group is isomorphic to the regular action of G on itself by right-multiplication.

For a (di)graph to be a DRR or GRR on G, it must be a Cayley (di)graph on G. Whenever the group G admits an automorphism that fixes the connection set of the Cayley (di)graph setwise, this induces a nontrivial graph automorphism that fixes the identity vertex, which means that the (di)graph is not a DRR or GRR. Checking whether or not there is any group automorphism that fixes a particular connection set can be done very quickly and easily compared with checking whether or not any nontrivial graph automorphism fixes some vertex, so it would be nice to know if there are circumstances under which the simpler test is enough to guarantee whether or not the Cayley graph is a GRR or DRR. I will present a number of results on this question.

This is based on joint work with Dave Morris and with Gabriel Verret.

TODD MULLEN, University of Prince Edward Island
[Sunday December 3 / dimanche 3 décembre, 8:00]
Pay it Backward

Pay it Backward is a wealth-sharing model on graphs. However, Pay it Backward is a "bad" model as it often results in great wealth disparity. This model is used to illustrate the possibility of finding periodicity in aperiodicity. With a focus on the unexpected quirks of research, this talk will hopefully be of particular use for new researchers.

SHIVARAM PRAGADA, SIMON FRASER UNIVERSITY
[Sunday December 3 / dimanche 3 décembre, 16:30]
Subdivision and Adjacency spectra of Graphs

Let G be the a graph with n vertices. Let $A(G)$ be its adjacency matrix. We denote the eigenvalues of $A(G)$ by

$$\lambda_1(G) \geq \lambda_2(G) \geq \cdots \geq \lambda_n(G).$$

Let $S \subseteq E(G)$. For $t \geq 1$, we define $G_t = G_t(S)$ to be the graph obtained from G by replacing each edge $uv \in S$ with a path P_{uv} of length t.

In this talk, we investigate the asymptotic nature of graph spectra when some edges of a graph are subdivided sufficiently many times. We show that, for a fixed k, the sequence $\{\lambda_k(G_t)\}_{t=0,1,2,\ldots}$ is a Cauchy sequence.

This is a joint work with Hitesh Kumar, Bojan Mohar and Hanmeng Zhan.

BEN SEAMONE, Dawson College
[Sunday December 3 / dimanche 3 décembre, 17:30]
Defective acyclic colourings of planar graphs

A vertex colouring of a graph G is called acyclic if the colouring is proper and any two colour classes induce an acyclic subgraph of G. It was shown by Borodin (1979) that every planar graph has an acyclic 5-colouring. Mondal, Nishat, Rahman, and Whitesides (2013) show that any planar triangulation can be made acyclically 3-colourable by subdividing $2n-5$ of its edges exactly once each, and acyclically 4-colourable by subdividing $\frac{3}{2}n - \frac{7}{2}$ of its edges exactly once each. We extend and complement these results by providing bounds on the number of edges whose deletion will make a planar graph acyclically 3-colourable or 4-colourable, and providing tight bounds on the minimum number of edges one needs to remove from a planar graph in order to turn any proper 3-colouring or 4-colouring into an acyclic colouring. Joint work with On-Hei Solomon Lo and Xuding Zhu.

MAHSA N. SHIRAZI, University of Manitoba
[Sunday December 3 / dimanche 3 décembre, 16:00]
Uniform hypergraphs and balanced incomplete block designs with r-friendship property

A t-uniform hypergraph $\mathcal{H}$ has r-friendship property if for every t-subset of vertices $v_1, \ldots, v_t$, there are exactly r vertices $w_1, \ldots, w_r$ such that for $(t-1)$-subsets A of vertices v_i, and any w_i, $A \cup \{w_i\}$ is a hyperedge in $\mathcal{H}$. Li et al. conjectured that no balanced incomplete block design (BIBD) has 1-friendship property. We show that if $\mathcal{H}$ is a 1-friendship t-uniform hypergraph that is a BIBD-(n, b, d, t, λ), then n is small enough with respect to λ. Furthermore, we present a class of 1-friendship t-uniform hypergraph that is a BIBD. We generalize our results to r-friendship t-uniform hypergraph and show no such hypergraphs are BIBD when n is large enough with respect to λ, t, and r.

MICHAEL TAIT, Villanova University
[Saturday December 2 / samedi 2 décembre, 9:00]
The largest eigenvalue of the normalized distance Laplacian matrix

We discuss two conjectures of Reinhart which seek to minimize or maximize the largest eigenvalue of the normalized distance Laplacian matrix over all connected n vertex graphs. We prove one of these conjectures and make significant progress towards the second. If λ is the largest eigenvalue over all normalized distance Laplacians of n vertex connected graphs, then $\lambda = 2 - \Theta\left(\frac{1}{\sqrt{n}}\right)$. We show that under any one of several natural conditions, the extremal graph must have diameter $\Theta(\sqrt{n})$.

JEREMIE TURCOTTE, McGill University
[Sunday December 3 / dimanche 3 décembre, 8:30]
On an induced version of Menger's theorem

Menger's theorem is one of the most fundamental results in graph theory: if G is a graph, either $A, B \subseteq V(G)$ can be separated by removing fewer than k vertices, or there exists k pairwise disjoint A-B paths. What happens if we wish these paths to not only be disjoint, but non-adjacent? This question, while interesting in its own right, is also motivated by the *Coarse Graph Theory* recently proposed by Georgakopoulos and Papasoglu. We show the existence of a constant C, which depends only on the maximum degree of G, such that either A, B can be separated by removing at most Ck vertices, or there exists k pairwise non-adjacent A-B paths. A generalization of this result to graphs with a forbidden topological minor will also be discussed, as well as more precise results for the subcubic case. Joint work with Kevin Hendrey, Sergey Norin and Raphael Steiner.

Descriptive Set Theory

Org: **Marcin Sabok** (McGill University) and/et **Assaf Shani** (Concordia University)

Descriptive set theory is concerned with the study of definable sets in Polish spaces. The techniques and results of the field found numerous applications and current research in descriptive set theory is intimately connected with many fields of mathematics, including mathematical logic, combinatorics, dynamical systems, topology, and geometric group theory.

Schedule/Horaire — Room/Salle: Symphonie 1

Saturday December 2 — samedi 2 décembre

15:00 - 15:30	Sumun Iyer (Cornell University), *Generic homeomorphisms of Knaster continua* (p. 100)
15:30 - 16:00	Chris Karpinski (McGill University), *Hyperfiniteness of boundary actions of groups* (p. 101)
16:00 - 16:30	Koichi Oyakawa (Vanderbilt University), *Hyperfiniteness of boundary actions of acylindrically hyperbolic groups* (p. 101)
16:30 - 17:00	Jenna Zomback (University of Maryland), *Boundary actions of free semigroups* (p. 102)
17:00 - 17:30	Spencer Unger (University of Toronto), *Circle squaring with algebraic irrational translations* (p. 102)
17:30 - 18:00	Forte Shinko (UC Berkeley), *Equivalence relations classifiable by Polish abelian groups* (p. 101)

Sunday December 3 — dimanche 3 décembre

8:30 - 9:00	Rehana Patel (Wesleyan University & African Institute for Mathematical Sciences, Senegal) (p. 101)
9:00 - 9:30	Iian Smythe (University of Winnipeg), *A descriptive approach to manifold classification* (p. 101)
9:30 - 10:00	Antoine Poulin (McGill University), *Space of Archimedean Left-Orders* (p. 101)
10:00 - 10:30	Rachael Alvir (University of Waterloo), *Scott Complexity* (p. 100)

Abstracts/Résumés

RACHAEL ALVIR, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 1]
Scott Complexity

The logic $L_{\omega_1\omega}$ is the extension of finitary first-order logic allowing countably infinite conjunctions and disjunctions. In this logic, every countable structure can be characterized up to isomorphism (among countable structures) by a single sentence known as a Scott sentence. The proof of this result reveals that a special ordinal, known as the Scott Rank of the structure, is of interest. Unfortunately, many non-equivalent definitions of Scott rank exist in the literature. In an attempt to standardize the definition of Scott rank, Antonio Montalban argued that we should define the Scott rank of A to be the least α such that A has a $\Pi_{\alpha+1}$ Scott sentence. This notion of Scott rank is robust, having many equivalent characterizations. In particular, one is able to show that this condition is equivalent to the set of presentations of A being boldface $\Pi_{\alpha+1}$ in the Borel hierarchy in the space Mod(L). However, when A has a Scott sentence with a different complexity also has many equivalent characterizations. The notion of Scott complexity is arguably the most refined such notion which retains a connection with the Borel hierarchy. In this talk, we introduce Scott complexity and then compute the Scott complexity for several classes of structures.

SUMUN IYER, Cornell University
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 1]
Generic homeomorphisms of Knaster continua

Knaster continua are a class of compact, connected, metrizable spaces which are indecomposable in the sense that they cannot be written as the union of two proper non-trivial compact, connected subspaces. Let K be the universal Knaster continuum

(this is a unique Knaster continuum which continuously and openly surjects onto all other Knaster continua). The group $\mathrm{Homeo}(K)$ of all homeomorphisms of the universal Knaster continuum is a non-locally compact Polish group. We prove that it contains an open, normal subgroup which has a comeager conjugacy class.

CHRIS KARPINSKI, McGill University
[Saturday December 2 / samedi 2 décembre, 15:30 – Symphonie 1]
Hyperfiniteness of boundary actions of groups

Groups with some notion of negative curvature (such as free groups, and more generally hyperbolic groups and their various generalizations) have a notion of a boundary at infinity, which is a Polish space on which the group acts by homeomorphisms. The actions of such groups on their boundaries have been shown to furnish examples of hyperfinite orbit equivalence relations, and hence have been of interest in descriptive set theory. We survey results on hyperfiniteness of boundary actions of various "negatively curved" groups, beginning with the simple case of free groups and demonstrating how the methods for free groups are applied to more general groups. We show, however, that these methods break down at the level of generality of "acylindrically hyperbolic groups", by outlining a construction of an acylindrically hyperbolic group exhibiting a non-hyperfinite boundary action.

KOICHI OYAKAWA, Vanderbilt University
[Saturday December 2 / samedi 2 décembre, 16:00 – Symphonie 1]
Hyperfiniteness of boundary actions of acylindrically hyperbolic groups

A Borel equivalence relation on a Polish space is called hyperfinite if it can be approximated by equivalence relations with finite classes. This notion has long been studied in descriptive set theory to measure complexity of Borel equivalence relations. Although group actions on hyperbolic spaces don't always induce hyperfinite orbit equivalence relations on the Gromov boundary, some natural boundary actions were recently found to be hyperfinite. Examples of such actions include actions of hyperbolic groups and relatively hyperbolic groups on their Gromov boundary, actions of mapping class groups on arc graphs and curve graphs, and acylindrical group actions on trees. In this talk, I will show that any acylindrically hyperbolic group admits a non-elementary acylindrical action on a hyperbolic space with hyperfinite boundary action.

REHANA PATEL, Wesleyan University & African Institute for Mathematical Sciences, Senegal
[Sunday December 3 / dimanche 3 décembre, 8:30 – Symphonie 1]

ANTOINE POULIN, McGill
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 1]
Space of Archimedean Left-Orders

We prove that the space of Archimedean orders on $\mathbb{Z}^3$ with the equivalence relation induced by the action of $\mathrm{GL}(n,\mathbb{Z})$ is not hyperfinite.

FORTE SHINKO, University of California, Berkeley
[Saturday December 2 / samedi 2 décembre, 17:30 – Symphonie 1]
Equivalence relations classifiable by Polish abelian groups

A conjecture of Hjorth states that the only countable Borel equivalence relations reducible to orbit equivalence relations of Polish abelian group actions are the hyperfinite ones. This conjecture was recently refuted by Allison, where he showed that every treeable countable Borel equivalence relation reduces to such an orbit equivalence relation. We show that this holds for more general equivalence relations, including all countable Borel equivalence relations. This is joint with Josh Frisch.

Descriptive Set Theory

IIAN SMYTHE, University of Winnipeg
[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 1]
A descriptive approach to manifold classification

We propose a unified descriptive set-theoretic framework for studying the complexity of classification problems arising in geometric topology. We establish several precise complexity results, such as for the classification of surfaces up to homeomorphism, and for classes of hyperbolic manifolds up to isometry. The latter is intimately connected with the conjugation actions of certain Lie groups on their spaces of discrete subgroups. This work is joint with Jeffrey Bergfalk.

SPENCER UNGER, University of Toronto
[Saturday December 2 / samedi 2 décembre, 17:00 – Symphonie 1]
Circle squaring with algebraic irrational translations

I will describe some joint work with Andrew Marks where we show that known circle squaring results can be done with translations whose coordinates are algebraic irrational.

JENNA ZOMBACK, University of Maryland, College Park
[Saturday December 2 / samedi 2 décembre, 16:30 – Symphonie 1]
Boundary actions of free semigroups

We consider the natural action of a free, finitely generated semigroup (the set of all finite words in a finite alphabet S) on its boundary (the space of infinite words in S) by concatenation. While boundary actions of free groups are well-studied, much less is known for semigroups. In joint work with Anush Tserunyan, we completely characterize those Markov measures which make the boundary action weakly mixing (i.e., the product with an ergodic probability measure preserving action is ergodic). This is an ingredient in the proof of pointwise ergodic theorems for measure preserving actions of free semigroups.

Functional Analytic tools for Financial Decision Making
Outils d'analyse fonctionnelle pour la prise de décision financière

Org: Mario Ghoussoub and/et **David Saunders** (University of Waterloo)

This session will feature approximately 8 speakers addressing applications of functional analysis to problems in decision making motivated by the finance and insurance industries. Topics include, but are not limited to, optimal reinsurance, decision making under ambiguity, robust risk measurement, and dependence structure ambiguity.

Schedule/Horaire **Room/Salle: UQAM - SH - 3260**

Saturday December 2 **samedi 2 décembre**

9:00 - 9:30	Luka Milic (Toronto Metropolitan University), *Investment Strategies in the Face of Climate Uncertainty: Balancing Transition and Physical Risks* (p. 104)
9:30 - 10:00	Matt Davison (Western University), *Data Science Insights and financial models about the Financial Behaviour of Canadians* (p. 103)
10:00 - 10:30	Samuel Solgon Santos (University of Waterloo), *Inducing comonotonic additive risk measures from acceptance sets* (p. 104)
15:00 - 15:30	Geneviève Gauthier (HEC Montréal), *Joint dynamics for the underlying asset and its implied volatility surface: A new methodology for option risk management* (p. 103)
15:30 - 16:00	Tony Ware (University of Calgary), *Operator splitting and optimal control of gas storage* (p. 105)
16:00 - 16:30	Jonathan Li (University of Ottawa), *On Generalization and Regularization via Wasserstein Distributionally Robust Optimization* (p. 104)
16:30 - 17:00	Marlon Moresco (Concordia University), *Uncertainty Propagation and Dynamic Robust Risk Measures* (p. 104)

Abstracts/Résumés

MATT DAVISON, Western University
[Saturday December 2 / samedi 2 décembre, 9:30 – UQAM - SH - 3260]
Data Science Insights and financial models about the Financial Behaviour of Canadians

I will describe the Financial Wellness Lab of Canada together with three groups of insights we have obtained during the last few years. 1) I will describe a cluster-based quantification of the real and self-perceived financial status of Canadian families, obtained from a comprehensive repeated survey of a large number of Canadians. 2) I will present an analysis of a voluminous database containing the trading behaviour of all of the clients of a financial management firm which allows the comparison of actual risk taken by Canadian investors with their stated risk appetite. 3) The same database also allows an assessment of the relative value of savings behaviour and market decisions in the wealth building process, which is the third example. I close with some outlooks on next steps and projects for our lab. This is is the work of many colleagues most notably Adam Metzler (Laurier) and Chuck Grace (Western) as well as many others to be named in the presentation.

GENEVIÈVE GAUTHIER, HEC Montréal
[Saturday December 2 / samedi 2 décembre, 15:00 – UQAM - SH - 3260]
Joint dynamics for the underlying asset and its implied volatility surface: A new methodology for option risk management

This paper develops a dynamic joint model of the implied volatility (IV) surface and its underlying asset which is tractable and seamless to estimate. It combines an asymptotically well-behaved, parametric IV surface representation with a two-component variance, and non-Gaussian asymmetric GARCH specification for the underlying asset returns. Estimated on S&P500 index return and option data for the 1996-2020 period, the model captures the IV surface movements well and uses them to obtain

an improved fit on index returns. It also proves to be an effective risk management tool, producing reliable Value-at-Risk estimates for straddle and strangle positions, and accurate forecasts of the VIX distribution.

JONATHAN LI, Telfer School of Management, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 16:00 – UQAM - SH - 3260]
On Generalization and Regularization via Wasserstein Distributionally Robust Optimization

Wasserstein distributionally robust optimization (DRO) has found success in operations research and machine learning applications as a powerful means to obtain solutions with favourable out-of-sample performances. Two compelling explanations for the success are the generalization bounds derived from Wasserstein DRO and the equivalency between Wasserstein DRO and the regularization scheme commonly applied in machine learning. Existing results on generalization bounds and the equivalency to regularization are largely limited to the setting where the Wasserstein ball is of a certain type and the decision criterion takes certain forms of an expected function. In this paper, we show that by focusing on Wasserstein DRO problems with affine decision rules, it is possible to obtain generalization bounds and the equivalency to regularization in a significantly broader setting where the Wasserstein ball can be of a general type and the decision criterion can be a general measure of risk, i.e., nonlinear in distributions. This allows for accommodating many important classification, regression, and risk minimization applications that have not been addressed to date using Wasserstein DRO. Our results are strong in that the generalization bounds do not suffer from the curse of dimensionality and the equivalency to regularization is exact. As a byproduct, our regularization results broaden considerably the class of Wasserstein DRO models that can be solved efficiently via regularization formulations.

LUKA MILIC, Toronto Metropolitan University
[Saturday December 2 / samedi 2 décembre, 9:00 – UQAM - SH - 3260]
Investment Strategies in the Face of Climate Uncertainty: Balancing Transition and Physical Risks

In this research, we study the influence of climate change on portfolio construction, focusing on the dual impact of transition and physical risks. We develop a dynamic model that integrates a two-factor mean-reverting framework to represent global temperature variations and transition factors related to climate change. The model is used to examine the optimal stock-bond-cash portfolio selection in a context marked by climate uncertainty. Our approach entails deriving an optimal investment strategy in closed form, initially formulated without considering climate uncertainty. The study also addresses the limitations inherent in a mean-reverting climate assumption and suggests the potential application of Energy Balance Models (EBMs) for a more accurate representation of the climate system. These EBMs open the avenue for leveraging advanced deep-learning techniques for optimal portfolio allocation. The results highlight the critical impact of climate uncertainty on investment strategies, advocating for the integration of climate risk considerations in portfolio management.

MARLON MORESCO, Concordia University
[Saturday December 2 / samedi 2 décembre, 16:30 – UQAM - SH - 3260]
Uncertainty Propagation and Dynamic Robust Risk Measures

We introduce a framework for quantifying propagation of uncertainty arising in a dynamic setting. Specifically, we define dynamic uncertainty sets designed explicitly for discrete stochastic processes over a finite time horizon. These dynamic uncertainty sets capture the uncertainty surrounding stochastic processes and models, accounting for factors such as distributional ambiguity. Examples of uncertainty sets include those induced by the Wasserstein distance and f-divergences. We further define dynamic robust risk measures as the supremum of all candidates' risks within the uncertainty set. In an axiomatic way, we discuss conditions on the uncertainty sets that lead to well-known properties of dynamic robust risk measures, such as convexity and coherence. Furthermore, we discuss the necessary and sufficient properties of dynamic uncertainty sets that lead to time-consistencies of robust dynamic risk measures. We find that uncertainty sets stemming from f-divergences lead to strong time-consistency while the Wasserstein distance results in a new notion of non-normalised time-consistency. Moreover, we show that a dynamic robust risk measure is strong or non-normalised time-consistent if and only if it admits a recursive representation of one-step conditional robust risk measures arising from static uncertainty sets.

Functional Analytic tools for Financial Decision Making
Outils d'analyse fonctionnelle pour la prise de décision financière

---

SAMUEL SOLGON SANTOS, University of Waterloo
[Saturday December 2 / samedi 2 décembre, 10:00 – UQAM - SH - 3260]
Inducing comonotonic additive risk measures from acceptance sets

We present general conditions on the acceptance sets under which their induced risk and deviation measures are comonotonic additive. We show that an acceptance set generates a comonotonic additive risk measure if and only if the acceptance set and its complement are closed for convex combinations of comonotonic random variables. This result generalizes to risk measures that are additive for random variables with *a priori* specified dependence structures, e.g., perfectly correlated, uncorrelated, or independent random variables.

TONY WARE, University of Calgary
[Saturday December 2 / samedi 2 décembre, 15:30 – UQAM - SH - 3260]
Operator splitting and optimal control of gas storage

We consider a natural gas storage facility where the gas is to be traded on a mixture of spot and forward markets. The problem of determining the optimal operating and marketing strategy for such a facility, and its associated value, is complicated by the range of potential markets for the gas, and by the physical characteristics of the facility which create state-dependent constraints on the allowable injection/withdrawal rates. In [SIAM JFM 4(1) 427-451, 2013] we proposed an operator-splitting approach for time-discretisation of the associated HJB equation in a simple one-factor spot price model, and proved convergence to the viscosity solution. Here we expand that approach to a multi-factor polynomial process setting, where the application of one of the operators corresponds to a set of intrinsic value computations exploiting the structure of the forward curve with injection/withdrawal rates conforming to system constraints.

Geometric Analysis
Analyse géométrique

Org: Siyuan Lu (McMaster University) and/et **Xiangwen Zhang** (University of California, Irvine)

Schedule/Horaire **Room/Salle: Symphonie 4A**

Saturday December 2 — samedi 2 décembre

8:00 - 8:40	Min Chen (McGill University), *Alexandrov-Fenchel type inequalities for hypersurfaces in the sphere* (p. 106)
8:50 - 9:30	Sebastien Picard (University of British Columbia), *Strominger system and complex geometry* (p. 107)
9:40 - 10:20	Chao-Ming Lin (Ohio State University), *On the solvability of general inverse σ_k equations* (p. 107)
15:00 - 15:40	Robert Haslhofer (University of Toronto), *Free boundary minimal disks in convex balls* (p. 107)
15:50 - 16:30	Ling Xiao (University of Connecticut), *Generalized Minkowski inequality via degenerate Hessian equations on exterior domains* (p. 107)
16:40 - 17:20	Zihui Zhao (Johns Hopkins University), *Unique continuation and the singular set of harmonic functions* (p. 108)

Sunday December 3 — dimanche 3 décembre

8:00 - 8:40	Tristan Collins (University of Toronto), *Uniqueness of Cylindrical Tangent Cones to some Special Lagrangians* (p. 106)
8:50 - 9:30	Edward Chernysh (McGill University), *A Struwe-Type Decomposition for Weighted p-Laplace equations of the Caffarelli-Kohn-Nirenberg Type* (p. 106)
9:40 - 10:20	Fang Hong (McGill University), *Sharpened Minkowski Inequality in Cartan-Hadamard Spaces* (p. 107)

Abstracts/Résumés

MIN CHEN, McGill University
[Saturday December 2 / samedi 2 décembre, 8:00 – Symphonie 4A]
Alexandrov-Fenchel type inequalities for hypersurfaces in the sphere

The Alexandrov-Fenchel inequalities in the Euclidean space are inequalities involving quermassintegrals of different orders and are classical topics in convex and differential geometry. Brendle-Guan-Li proposed a conjecture on the corresponding inequalities for quermassintegrals in the sphere. In this talk, we introduce some new progress on this Conjecture.

EDWARD CHERNYSH, McGill
[Sunday December 3 / dimanche 3 décembre, 8:50 – Symphonie 4A]
A Struwe-Type Decomposition for Weighted p-Laplace equations of the Caffarelli-Kohn-Nirenberg Type

In this talk, we establish a Struwe-type decomposition result for a class of critical p-Laplace equations of the Caffarelli-Kohn-Nirenberg type in smoothly bounded domains $\Omega \subset \mathbb{R}^n$ for $n \geq 3$. More precisely, we investigate the relative compactness of Palais-Smale sequences associated to the critical elliptic problem

$$\begin{cases} -\operatorname{div}\left(|\nabla u|^{p-2}\,\nabla u\,|x|^{-ap}\right) = |u|^{q-2}\,u\,|x|^{-bq} & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega. \end{cases}$$

Here, $1 < p < n$ and $q := np/(n - p(1 + a - b))$ under suitable conditions for a, b. In doing so, we highlight crucial differences between the weighted setting and the pioneering work of Michael Struwe in the unweighted model $p = 2$ case.

Geometric Analysis
Analyse géométrique

TRISTAN COLLINS, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 8:00 – Symphonie 4A]
Uniqueness of Cylindrical Tangent Cones to some Special Lagrangians

I will explain a proof of the following result: if an exact special Lagrangian $N \subset \mathbb{C}^n$ has a multiplicity one, cylindrical tangent cone of the form $\mathbb{R}^k \times C$ where C is a special Lagrangian cone with smooth, connected link, then this tangent cone is unique provided C satisfies an integrability condition. This applies, for example, to the Harvey-Lawson T^{m-1} cones for $m \neq 8, 9$. This is joint work with Y. Li.

ROBERT HASLHOFER, University of Toronto
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 4A]
Free boundary minimal disks in convex balls

We prove that every strictly convex 3-ball with nonnegative Ricci-curvature contains at least 3 embedded free-boundary minimal 2-disks for any generic metric, and at least 2 solutions even without genericity assumption. Our approach combines ideas from mean curvature flow, min-max theory and degree theory. We also establish the existence of smooth free-boundary mean-convex foliations. This is joint work with Dan Ketover.

FANG HONG, McGill University
[Sunday December 3 / dimanche 3 décembre, 9:40 – Symphonie 4A]
Sharpened Minkowski Inequality in Cartan-Hadamard Spaces

Minkowski inequality describes the relationship between total mean curvature of a surface and its area. Extension of Minkowski inequality to hyperbolic space and finding the sharp inequality have been a long standing problem. We will discuss a recent paper by M. Ghomi and J. Spruck and sharper inequality we get based on their proof, in which we generalized Minkowski inequality to general spaces with non-positive curvature via harmonic mean curvature flow.

CHAO-MING LIN, Ohio State University
[Saturday December 2 / samedi 2 décembre, 9:40 – Symphonie 4A]
On the solvability of general inverse σ_k equations

In this talk, first, I will introduce general inverse σ_k equations in Kähler geometry. Some classical examples are the complex Monge–Ampère equation, the J-equation, the complex Hessian equation, and the deformed Hermitian–Yang–Mills equation. Second, by introducing some new real algebraic geometry techniques, we can consider more complicated general inverse σ_k equations. Last, analytically, we study the solvability of these complicated general inverse σ_k equations.

SEBASTIEN PICARD, UBC
[Saturday December 2 / samedi 2 décembre, 8:50 – Symphonie 4A]
Strominger system and complex geometry

The Strominger system is the set of fundamental equations of supersymmetric heterotic string theory over a Calabi-Yau threefold. It combines the Yang-Mills equation on a vector bundle with a constraint equation on the Riemannian curvature tensor. We will survey current developments on these equations.

LING XIAO, University of Connecticut
[Saturday December 2 / samedi 2 décembre, 15:50 – Symphonie 4A]
Generalized Minkowski inequality via degenerate Hessian equations on exterior domains

In this talk, we will talk about the proof of a sharp generalized Minkowski inequality that holds for any smooth, strictly $(k-1)$-convex, star-shaped domain Ω. Our proof relies on the solvability of the degenerate k-Hessian equation on the exterior domain $R^n \setminus \Omega$.

ZIHUI ZHAO, Johns Hopkins University
[Saturday December 2 / samedi 2 décembre, 16:40 – Symphonie 4A]
Unique continuation and the singular set of harmonic functions

Unique continuation property is a fundamental property for harmonic functions, as well as a large class of elliptic and parabolic PDEs. It says that if a harmonic function vanishes at a point to infinite order, it must vanish everywhere. In the same spirit, we are interested in quantitative unique continuation problems, where we use the local growth rate of a harmonic function to deduce some global estimates, such as estimating the size of its singular or critical set set. In this talk, I will talk about some recent results together with C. Kenig on boundary unique continuation.

Geometric Functional Analysis: Analytic, Discrete, and Probabilistic Aspects
Analyse fonctionnelle géométrique : Aspects analytiques, discrets et probabilistes

Org: Serhii Myroshnychenko (University of the Fraser Valley), **Michael Roysdon** (Case Western Reserve University), **Beatrice-Helen Vritsiou** (University of Alberta) and/et **Deping Ye** (Memorial)

Geometric Functional Analysis deals with questions arising in the fields of Convex and Discrete Geometry, Probability and Information Theory, Harmonic and Functional Analysis, and even Algebraic Geometry. The central ingredient which links all of the above is the study of the nature and properties of convex bodies in finite dimensional normed spaces and associated functional extensions that find real life applications in questions arising from Computer Science and Quantum Information, Medical Tomography, Economics, Data Science and Machine Learning. Methods employed in the field include, but are not limited to, the celebrated concentration of measure phenomena, Fourier analysis and integral transforms, optimal transport, calculus of variations, and Riemannian geometric approaches.

This field is relatively young and numerous problems and central concepts are accessible to mathematicians of various backgrounds and at different stages of their career. Simultaneously, Geometric Functional Analysis has many interesting long-standing open questions, among which are Bourgain's slicing problem, the Kannan-Lovlasz-Simonovits conjecture, Mahler's conjecture, the Kneser-Poulsen conjecture, and the log-Brunn-Minkowski conjecture to name a few.

The principal goal of this gathering will be to encourage synergies between experts and students coming from various fields of geometry, analysis, applied mathematics, and beyond, by promoting research in such problems and related ones, while helping to establish/expand a network of diverse collaborations.

Schedule/Horaire

Saturday December 2 — samedi 2 décembre

8:00 - 8:30	Nguyen H. Lam (Memorial University, Canada), *A new approach to weighted Hardy-Rellich inequalities* (p. 112)
8:30 - 9:00	Zengle Zhang (Chongquing University of Arts and Sciences, China), *The dual Orlicz-Minkowski problems for log-concave functions* (p. 115)
9:00 - 9:30	Yiming Zhao (Syracuse University, USA), *The Minkowski problem in Gaussian probability space* (p. 115)
9:30 - 10:00	Chengjun Yue (Memorial University, Canada), *Around Poisson-Bessel potentials of fractional L^1-Hardy-Sobolev spaces* (p. 114)
10:00 - 10:30	Alexander Koldobsky (University of Missouri, USA), *Comparison problems for the Radon transform* (p. 112)
15:00 - 15:30	Ryan Gibara (U. Cincinatti, USA), *Traces and extensions of Sobolev functions in metric measure spaces* (p. 111)
15:30 - 16:00	Alexander Litvak (University of Alberta, Canada), *On the minimum of Gaussian variables.* (p. 112)
16:00 - 16:30	Rui Sun (University of Alberta, Canada), *Measure of Axiality for Convex Figures* (p. 114)
16:30 - 17:00	Kenneth Moore (University of British Columbia), *Minimal reflective and folding symmetry of convex sets* (p. 113)
17:00 - 17:30	Bartlomiej Zawalski (Kent State, USA), *On star-convex bodies with rotationally invariant sections* (p. 114)
17:30 - 18:00	Andrii Arman (University of Manitoba, Canada), *On some covering problems related to Borsuk's conjecture* (p. 110)

Sunday December 3 — dimanche 3 décembre

8:00 - 8:30	Gioacchino Antonelli (Courant Institute, USA), *Nonnegative curvature and existence of isoperimetric sets* (p. 110)
8:30 - 9:00	Almut Burchard (University of Toronto), *On pointwise (non)-monotonicity of heat kernels for metrics on the two-sphere* (p. 110)
9:00 - 9:30	Brayden Letwin (University of Alberta, Canada), *On a generalization of Grünbaum's inequality* (p. 112)

Geometric Functional Analysis: Analytic, Discrete, and Probabilistic Aspects
Analyse fonctionnelle géométrique : Aspects analytiques, discrets et probabilistes

9:30 - 10:00	Eli Putterman (TAU, Israel), *Small-ball probabilities for mean widths of random polytopes* (p. 113)
10:00 - 10:30	Julian Haddad (University of Sevilla, Spain), *Fiber symmetrization and the Rogers-Brascamp-Lieb-Luttinger inequality* (p. 111)
15:00 - 15:30	Mokshay Madiman (University of Delaware, USA), *Submodularity questions in convex geometry* (p. 113)
15:30 - 16:00	Dylan Langharst (Institut Math Jessieu, France), *On the measures satisfying a monotonicity of the surface area with respect to Minkowski sum* (p. 112)
16:00 - 16:30	Dmitry Faifman (Tel Aviv University, Israel), *Some Whitney extension problems in valuation theory* (p. 111)
16:30 - 17:00	Zhen Shuang (Memorial University), *Fractional p-Laplacian and Signal Decomposition* (p. 113)
17:00 - 17:30	Joshua Flynn (Mcgill University, Canada), *The Isoperimetric Problem and Related Mean Curvature Type Flows* (p. 111)

Abstracts/Résumés

GIOACCHINO ANTONELLI, Courant Institute (NYU)
[Sunday December 3 / dimanche 3 décembre, 8:00]
Nonnegative curvature and existence of isoperimetric sets

The isoperimetric problem is a well-known variational problem in Geometric Analysis. In this talk we will first review the recent literature on the existence of isoperimetric sets in spaces with nonnegative curvature. Then we will show how to construct a convex body C in $\mathbb{R}^3$ such that for every volume $v < 1$ there is no relative isoperimetric set with volume v, and for every volume $v > 1$ there is at least one relative isoperimetric set with volume v.

This is based on recent works with E. Bruè, M. Fogagnolo, F. Glaudo, and M. Pozzetta.

ANDRII ARMAN, University of Manitoba
[Saturday December 2 / samedi 2 décembre, 17:30]
On some covering problems related to Borsuk's conjecture

Borsuk's number $f(n)$ is the smallest integer such that any set of diameter 1 in n-dimensional Euclidean space can be covered by $f(n)$ sets of a smaller diameter. Exponential upper bound $f(n) \leq \left(\sqrt{\frac{3}{2}} + o(1)\right)^n$ was first obtained by Schramm (1988) and later by Bourgain and Lindenstrauss (1989), while a lower bound $f(n) \geq (1.2 + o(1))^{\sqrt{n}}$ was obtained by Kahn and Kalai (1993).

To obtain an upper bound on $f(n)$, Bourgain and Lindenstrauss provided exponential bounds (both upper and lower) for the Grünbaum's problem – the problem of determining the minimal number of open balls of diameter 1 needed to cover a set of diameter 1.

On the other hand, in order to obtain an upper bound on $f(n)$ Schramm provided an exponential upper bound on the illumination number of n-dimensional bodies of constant width. Kalai (2015) asked for a corresponding lower bound, namely if there exists an n-dimensional convex body of constant width with the illumination number exponential in n.

In this talk I will outline the construction that answers Kalai's question in the affirmative and provide a new lower bound in the Grünbaum's problem. The talk is based on a joint work with Andriy Bondarenko and Andriy Prymak.

ALMUT BURCHARD, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 8:30]
On pointwise (non)-monotonicity of heat kernels for metrics on the two-sphere

I will present recent work with Ángel Martínez, regarding pointwise monotonicity of heat kernels. Previously we had found that Riemannian metrics for which the heat kernel $K_t(x, y)$ decreases as x moves away from y along a minimal geodesic are extremely rare, though there are non-trivial examples (beyond products of standard spheres). Here we show that the only metrics on $\mathbb{S}^2$ with this monotonicity property are the uniform ones. The proof depends on a surprising connection with Hersch's inequality for the principal eigenvalue of the Laplacian.

DMITRY FAIFMAN, Tel Aviv University
[Sunday December 3 / dimanche 3 décembre, 16:00]
Some Whitney extension problems in valuation theory

Consider smooth, translation-invariant valuations on convex bodies. Assume that a collection of valuations is given on a family S of subspaces of $\mathbb{R}^n$. Are they the restrictions of a single valuation? Clearly, compatibility of the given data on intersections is a necessary condition. Is it sufficient? We will discuss several distinct instances of this problem, whence it acquires distinct flavors. When S is the whole k-grassmannian, and the valuations j-homogeneous, we will see that the condition is sufficient, provided $k - j > 1$. This can be seen as a dimensional localization of the phase transition from densities to valuations. In another setting, where S consists of pairwise non-intersecting subspaces, we again establish a positive answer. As a corollary, we will deduce a Nash embedding theorem for smooth valuations on manifolds, which in turn has integral-geometric consequences in this setting. Finally, we will consider the setting of finite generic families of subspaces, giving rise to a surprising extension phenomenon. Based on a joint work with Georg Hofstaetter.

JOSHUA FLYNN, CRM/ISM, McGill University
[Sunday December 3 / dimanche 3 décembre, 17:00]
The Isoperimetric Problem and Related Mean Curvature Type Flows

The isoperimetric problem asks to find, among all domains of a given volume, those whose boundaries have minimal surface area. A natural approach to this problem is to consider volume preserving and area decreasing geometric flows. In this talk, we introduce a flow which is a novel modification of the mean curvature-type flow first introduced by Guan and Li, which was later generalized by Guan-Li-Wang and Li-Pan. These flows are defined in terms of conformal Killing vector fields and rely on Minkowski identities to prove volume preservation and area monotonicity. Our results allow one to establish the isoperimetric inequalities in general geometries for a category of surfaces larger than the usual star-shaped or convex categories all previous works were restricted to.

RYAN GIBARA, University of Cincinnati
[Saturday December 2 / samedi 2 décembre, 15:00]
Traces and extensions of Sobolev functions in metric measure spaces

In smooth Euclidean domains, it is known that Sobolev functions admit traces to the boundary that are in an appropriate Besov class and, vice versa, Besov functions on the boundary admit extensions that are Sobolev in the domain. All of these concepts make sense in the setting of a metric measure space, where the geometry of the space, as manifested in the existence of well behaved curves, plays a key role. In this talk, we will discuss recent work on generalizing the known trace and extension results to unbounded domains. This work, joint with Riikka Korte and Nageswari Shanmugalingam, arose in connection to the study of Dirichlet problems for the p-Laplacian on unbounded uniform domains in metric measure spaces.

JULIAN HADDAD, Universidad de Sevilla
[Sunday December 3 / dimanche 3 décembre, 10:00]
Fiber symmetrization and the Rogers-Brascamp-Lieb-Luttinger inequality

Abstract: We prove a Rogers-Brascamp-Lieb-Luttinger inequality for functions defined in the space of $n \times m$ matrices, using

a particular form of fiber-symmetrization. Some applications on symmetrization of matrix norms are given. We also discuss a conjectured inequality by Schneider, on the higher-order difference body.

ALEXANDER KOLDOBSKY, University of Missouri-Columbia
[Saturday December 2 / samedi 2 décembre, 10:00]
Comparison problems for the Radon transform

Given two non-negative functions f and g such that the Radon transform of f is pointwise smaller than the Radon transform of g, does it follow that the L^p-norm of f is smaller than the L^p-norm of g for a given $p > 1$? We consider this problem for the classical and spherical Radon transforms. In both cases we point out classes of functions for which the answer is affirmative, and show that in general the answer is negative if the functions do not belong to these classes. The results are in the spirit of the solution of the Busemann-Petty problem from convex geometry, and the classes of functions that we introduce generalize the class of intersection bodies introduced by Lutwak in 1988. We also deduce slicing inequalities that are related to the well-known Oberlin-Stein type estimates for the Radon transform.

NGUYEN H. LAM, Memorial University of Newfoundland
[Saturday December 2 / samedi 2 décembre, 8:00]
A new approach to weighted Hardy-Rellich inequalities

In this talk, we present a new way to use the notion of Bessel pair to establish the optimal Hardy-Rellich type inequalities. We also talk about necessary and sufficient conditions on the weights for the Hardy-Rellich inequalities to hold. Symmetry and symmetry breaking properties of the Rellich type and Hardy-Rellich type inequalities will also be discussed. This is joint work with Anh Do and Guozhen Lu.

DYLAN LANGHARST, Institut de mathématiques de Jussieu
[Sunday December 3 / dimanche 3 décembre, 15:30]
On the measures satisfying a monotonicity of the surface area with respect to Minkowski sum

If K and L are convex bodies, then K being a subset of L implies the surface area of K is less than the surface area of L. If A,B and C are also convex bodies, then the Lebesgue measure satisfies the following supermodularity inequality for their Minkowski sums: $|A+B|+|A+C| < |A|+|A+B+C|$. In this talk, we explore weighted analogues of these properties by replacing the Lebesgue measure with a nice Borel measure. Recently, G. Saracco and G. Stefani showed that if a Borel measure with density has the monotonicity property, then it must be a multiple of the Lebesgue measure. We study the case of supermodularity for any Radon measure, and show it is equivalent to a variant of the monotonicity problem. We verify that a Radon measure with the supermodularity property must be the Lebesgue measure. We then consider restricted versions of the problem.

BRAYDEN LETWIN, University of Alberta
[Sunday December 3 / dimanche 3 décembre, 9:00]
On a generalization of Grünbaum's inequality

Grünbaum's inequality gives sharp volume bounds between a convex body and a division of the body by a hyperplane through its centroid. We provide a generalization of this inequality by looking at divisions of the body by a hyperplane that does not necessarily contain the centroid. As an application, we arrive at a sharp inequality that compares the maximal section(s) of a convex body to any section, which builds on work done by Makai and Martini in 1996. This is joint work with Vlad Yaskin.

ALEXANDER LITVAK
[Saturday December 2 / samedi 2 décembre, 15:30]
On the minimum of Gaussian variables.

Let $X = (\xi_1, ..., \xi_m)$ be a centered Gaussian random vector, such that the variances of each ξ_i equals to 1. Under what assumptions on the covariance matrix is the expectation of $\min_i |\xi_i|$ minimized ? We discuss known results and conjectures related to this question.

MOKSHAY MADIMAN, University of Delaware
[Sunday December 3 / dimanche 3 décembre, 15:00]
Submodularity questions in convex geometry

I will present some results, obtained in collaboration with M. Fradelizi, M. Meyer, and A. Zvavitch, on the log-submodularity of the volume of Minkowski sums on different classes of compact convex sets. The underlying question is the following: given a class $\mathcal{G}_n$ of compact convex sets in $\mathbb{R}^n$ closed under Minkowski summation and affine transformations, and $A, B, C \in \mathcal{G}_n$, what is the best constant α in the inequality

$$|A + B + C| \cdot |A| \leq \alpha |A + B| \cdot |A + C|,$$

where $|\cdot|$ denotes volume ? This constant, which we may denote $\alpha(\mathcal{G}_n)$, has interesting interpretation, and it is particularly useful to identify cases where it is equal to 1, since in this case, it is intimately connected to inequalities for projections. If $\mathcal{K}_n$ is the collection of compact convex sets and $\mathcal{Z}_n$ is the collection of zonoids in $\mathbb{R}^n$, we show that $\alpha(\mathcal{K}_2) = \alpha(\mathcal{Z}_2) = 1$ and $1 = \alpha(\mathcal{Z}_3) < \alpha(\mathcal{K}_3) = 4/3$. We will also present some estimates and some conjectures for higher dimensions.

KENNETH MOORE, University of British Columbia
[Saturday December 2 / samedi 2 décembre, 16:30]
Minimal reflective and folding symmetry of convex sets

In this talk, we discuss two generalizations of the Kovner-Besicovitch measure of symmetry. For a convex body in $\mathbb{R}^n$, the k-symmetry is defined as the largest possible ratio of overlap of the body and its reflection through a k-dimensional affine subspace. Chakerian and Stein proved general lower bounds for k-symmetry in 1965, but construction of low symmetry objects appeared to be difficult in dimensions above 2. We present an inductive construction that attains the current best upper bounds on minimal k-symmetry. We also show new upper and lower bounds for another version of symmetry first studied by Lassak, called folding symmetry, in $\mathbb{R}^2$. We will offer a few conjectures and promising directions. This talk is based on a joint work with Ritesh Goenka, Rui Sun, and Ethan White.

ELI PUTTERMAN, Tel Aviv University
[Sunday December 3 / dimanche 3 décembre, 9:30]
Small-ball probabilities for mean widths of random polytopes

The classical theory of random polytopes addresses questions such as computing the expectation or variance of geometric parameters associated to a random polytope (e.g., volume, number of facets, or mean width) ; more recent theory also aims to obtain concentration of measure for such quantities. The new theory of higher-order projection bodies naturally leads to a question in random polytopes which current theory, surprisingly, does not address: bounding a high negative moment of the mean width of a certain random polytope, which requires bounding the probability that this mean width is a small fraction of its expectation ("small-ball estimates"). These small-ball estimates use different tools from those commonly employed in the field of random polytopes, and it turns out that the behavior of the negative moment demonstrates a phase transition. We will conclude by mentioning some related open problems.

ZHEN SHUANG, Memorial University of Newfoundland
[Sunday December 3 / dimanche 3 décembre, 16:30]
Fractional p-Laplacian and Signal Decomposition

The fractional p-Laplacian $(-\Delta)_p^{\frac{\alpha}{2}}$ can be recovered by a weighted Laplace operator

$$div_{x,\tau}\big(\tau^{1-\alpha p 2^{-1}}\nabla_{x,\tau}u(x,\tau)\big)$$

through a limit of a function in the one-more-dimensional upper space. Hence an evolutionary equation with fractional p-Laplacian can be replaced with another one with the weighted Laplace operator to perform signal decomposition since it takes too much time to approximate the fractional p-Laplace evolutionary equation. The signal decomposition is to decompose a signal into different smoothness degrees.

RUI SUN, University of Alberta
[Saturday December 2 / samedi 2 décembre, 16:00]
Measure of Axiality for Convex Figures

For a convex body K in R^2 with $\mu(K) = 1$, the Kovner Besicovitch theorem states that one can inscribe a centrally symmetric (symmetric about a point) body of area at least 2/3 inside K. The minimizer is given by the triangle, where the maximal inscribable centrally symmetric body has only area of 2/3. In the spirit of this theorem, we consider the question: what is area of the largest convex body which we can inscribe in K that is symmetric about a line (we call this axiality) ? Lassak showed that for any K, this number is at least 2/3. Unlike in the centrally symmetric case, no minimizer was found to verify if this lower bound is sharp. In our paper, we are able to improve this bound to 0.695. On the other hand, the known concrete examples of bodies with low axiality had an axiality of $2\sqrt{2}-2 \approx 0.828$ which is attained by triangles and a specific parallelogram (and thus giving us an upperbound on the axiality of arbitrary convex bodies). Only recently, Choi discovered a quadrilateral which improved this upper bound to 0.816. We found an example with axiality $\frac{1}{3}(\sqrt{2}+1)$ and believe this to be the minimizer. I will explain in my presentation of how we attain the improvements on the upper and lower bounds of axiality. This talk is based on a joint work with Ritesh Goenka, Kenneth Moore, and Ethan White.

CHENGJUN YUE, Memorial University of Newfoundland
[Saturday December 2 / samedi 2 décembre, 9:30]
Around Poisson-Bessel potentials of fractional L^1-Hardy-Sobolev spaces

Let $u_\alpha(x,t)$, $\alpha \in (0,2)$ be the solution of the equation

$$\Delta_{x,t}u_\alpha(x,t) + (1-\alpha)t^{-1}\partial_t u_\alpha(x,t) = 0$$

on $\mathbb{R}^{n+1}_+ = \mathbb{R}^n \times (0,\infty)$ subject to $u_\alpha(x,0) = f(x)$ on $\mathbb{R}^n$. As the endpoint of the Poisson-Bessel potential u_α, the potential $u_0(x,t)$ solves the equation

$$\Delta_{x,t}\big(\ln t^{-1})u_0(x,t)\big) + t^{-1}\partial_t\big((\ln t^{-1})u_0(x,t)\big) = 0$$

on $\mathbb{R}^{n+1}_+$ subject to $u_0(x,0) = f(x)$ on $\mathbb{R}^n$. The main goal of this paper is to characterize a nonnegative measure μ on $\mathbb{R}^{n+1}_+$ such that $f(x) \mapsto u_\alpha(x,t)$ induces a bounded embedding from the fractional L^1-Hardy-Sobolev space $H^{\alpha,1}(\mathbb{R}^n)$, $\alpha \in (0,2)$ into the weak Lebesgue space $WL^q_\mu(\mathbb{R}^{n+1}_+)$, $q \in [1,\infty)$ and $f(x) \mapsto u_0(x,t)$ induces a bounded embedding from the Hardy $H^{0,1}(\mathbb{R}^n)$ into the Lebesgue space $L^q_\mu(\mathbb{R}^{n+1}_+)$, $q \in [1,\infty)$.

Based on these trace principles, we propose $(H^{\alpha,1}, L^q)$ model and $(H^{\alpha,1}, \log)$ model for image denoising, which significantly improve the reconstruction from images polluted by Gaussian noise or Poisson noise compared with the famous Rudin-Osher-Fatemi model.

BARTLOMIEJ ZAWALSKI, Kent State University, Department of Mathematical Sciences
[Saturday December 2 / samedi 2 décembre, 17:00]
On star-convex bodies with rotationally invariant sections

We will outline the proof that an origin-symmetric star-convex body K with sufficiently smooth boundary and such that every hyperplane section of K passing through the origin is a body of affine revolution, is itself a body of affine revolution. This will give a positive answer to the recent question asked by G. Bor, L. Hernández-Lamoneda, V. Jiménez de Santiago, and L. Montejano-Peimbert [DOI:10.2140/gt.2021.25.2621, Remark 2.9], though with slightly different prerequisites. Our argument is built mainly upon the tools of differential geometry and linear algebra, but occasionally we will need to use some more involved facts from other fields like algebraic topology or commutative algebra. The talk is based on the article [DOI:10.1007/s13366-023-00702-1].

ZENGLE ZHANG, Chongqing University of Arts and Sciences
[Saturday December 2 / samedi 2 décembre, 8:30]
The dual Orlicz-Minkowski problems for log-concave functions

The dual curvature measure of convex bodies is a geometric measure induced by dual quermassintegrals of convex bodies and is a central concept of the dual Brunn-Minkowski theory. This measure was first introduced by Huang-LYZ. Related Minkowski problems have attracted a great deal of attention. In particular, the dual Minkowski problem can be reformulated as a Monge-Ampère equation involving radial functions of convex bodies. Recently, the dual Minkowski problem has been extended to the setting of unbounded convex sets, log-concave functions, and as well as the Orlicz theory.

In this talk, I will discuss the Orlicz moment and the related variational formula in terms of the Asplund sum of log-concave functions. I will talk about the related dual Orlicz curvature measure of log-concave functions and the corresponding Minkowski problem. A solution to this dual Minkowski problem will be presented for even data as well. This talk is based on the joint work with Niufa Fang, Deping Ye, and Yiming Zhao.

YIMING ZHAO, Syracuse University
[Saturday December 2 / samedi 2 décembre, 9:00]
The Minkowski problem in Gaussian probability space

The classical Minkowski problem, which asks for the characterization of surface area measure in Euclidean space with Lebesgue measure, largely motivated the development of elliptic PDEs throughout the last century. In this talk, we will discuss the corresponding problem in Gaussian probability space and some recent results. This is based on joint works with Yong Huang, Dongmeng Xi, and with Shibing Chen, Shengnan Hu, Weiru Liu.

Geometric Partial Differential Equations
Équations géométriques différentielles partielles

Org: Tristan Collins (MIT) and/et **Robert Haslhofer** (University of Toronto)

The focus of this session is on recent advances in geometric PDEs. This includes in particular recent breakthroughs in the study of minimal surfaces, Ricci curvature and geometric flows. The purpose is to expose junior mathematicians to these exciting recent developments in geometry and PDE, and to bring together researchers working on related topics to trigger collaborations.

Schedule/Horaire **Room/Salle: Symphonie 2A**

Saturday December 2 **samedi 2 décembre**

9:00 - 9:30	Marcin Sroka (CRM), *On the conjecture of Alesker-Verbitsky* (p. 118)
9:30 - 10:00	Bin Guo (Rutgers), *Geometric estimates in Kähler geometry* (p. 117)
10:00 - 10:30	Freid Tong (Harvard), *On a free boundary Monge-Ampere equation and complete Calabi-Yau metrics* (p. 118)
15:00 - 15:30	Shih-Kai Chiu (Vanderbilt), *Special Lagrangian spheres in adiabatic limits* (p. 116)
15:30 - 16:00	Spiro Karigiannis (University of Waterloo), *A special class of p-harmonic maps inducing calibrated fibrations* (p. 117)
16:00 - 16:30	Xinrui Zhao (MIT), *Unique continuation problem on RCD spaces* (p. 118)
17:00 - 17:30	Nicholas McCleerey (Purdue), *Singularities of m-subharmonic Functions* (p. 117)
17:30 - 18:00	Siyuan Lu (McMaster University), *Curvature estimates for semi-convex solutions of Hessian equations* (p. 117)

Sunday December 3 **dimanche 3 décembre**

9:00 - 9:30	Bruno Staffa (University of Toronto), *Generic density of geodesic nets* (p. 118)
9:30 - 10:00	Akashdeep Dey (University of Toronto), *Existence of closed geodesics on certain non-compact Riemannian manifolds* (p. 117)
10:00 - 10:30	Tristan Ozuch (MIT), *Selfduality along Ricci flow and instabilities of Einstein metrics* (p. 118)

Abstracts/Résumés

PAULA BURKHARDT-GUIM, NYU Courant
[Symphonie 2A]
ADM mass for C^0 metrics and distortion under Ricci-DeTurck flow

We show that there exists a quantity, depending only on C^0 data of a Riemannian metric, that agrees with the usual ADM mass at infinity whenever the ADM mass exists, but has a well-defined limit at infinity for any continuous Riemannian metric that is asymptotically flat in the C^0 sense and has nonnegative scalar curvature in the sense of Ricci flow. Moreover, the C^0 mass at infinity is independent of choice of C^0-asymptotically flat coordinate chart, and the C^0 local mass has controlled distortion under Ricci-DeTurck flow when coupled with a suitably evolving test function.

SHIH-KAI CHIU, Vanderbilt University
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 2A]
Special Lagrangian spheres in adiabatic limits

In a seminal paper, Harvey and Lawson defined special Lagrangians as certain calibrated submanifolds in Calabi-Yau manifolds. Special Lagrangians have since played a significant role in mirror symmetry, including the SYZ conjecture and stability conditions

in Fukaya categories. In this talk, we will discuss the construction of special Lagrangian 3-spheres in a collapsing Calabi-Yau 3-fold that admits a K3 fibration. As the ambient manifold collapses to the base, these special Lagrangians themselves collapse into geodesic segments within the base. This is joint work with Yu-Shen Lin.

AKASHDEEP DEY, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 2A]
Existence of closed geodesics on certain non-compact Riemannian manifolds

By the works of Birkhoff and Fet-Lyusternik, every closed Riemannian manifold admits a closed geodesic. In general, this theorem does not hold on non-compact manifolds. By the works of Thorbergsson and Bangert, every complete Riemannian surface, which contains a bounded concave open set, admits a closed geodesic. Recently, Chambers, Liokumovich, Nabutovsky and Rotman proved that every complete Riemannian manifold M, which contains a bounded concave open set U, admits a stationary geodesic net, which has at most one singular vertex. They also conjectured that such a manifold contains a closed geodesic. In this talk, we will discuss a proof of this conjecture assuming $M \setminus U$ is connected and either the relative homotopy set $\pi_1(M, M \setminus U) = 0$ or the relative homology group $H_1(M, M \setminus U) \neq 0$.

BIN GUO, Rutgers - Newark
[Saturday December 2 / samedi 2 décembre, 9:30 – Symphonie 2A]
Geometric estimates in Kähler geometry

We will discuss the role of complex Monge-Ampere equations as auxiliary equations in deriving sharp analytic and geometric estimates in Kahler geometry. By studying Green's functions, we will explore how to derive estimates for diameters and establish uniform Sobolev inequalities on Kähler manifolds, which depend only on entropy of the volume form and are independent of the lower bound of the Ricci curvature. This talk is based on joint works with D. H. Phong, J. Song, and J. Sturm.

SPIRO KARIGIANNIS, University of Waterloo
[Saturday December 2 / samedi 2 décembre, 15:30 – Symphonie 2A]
A special class of p-harmonic maps inducing calibrated fibrations

Let (M, g) be a Riemannian manifold equipped with a calibration form α. In earlier work with Cheng and Madnick (AJM 2021), we introduced a special class of p-harmonic maps into M satisfying a first order nonlinear PDE, whose images are α-calibrated submanifolds of M. In new joint work with my PhD student Anton Iliashenko, we have obtained analogous results for maps out of M. More precisely, we define a special class of p-harmonic maps out of M, satisfying a first order nonlinear PDE, whose fibres are α-calibrated submanifolds of M. I will also discuss very speculative potential future applications to existence of calibrated fibrations and the Strominger-Yau-Zaslow conjecture.

SIYUAN LU, McMaster University
[Saturday December 2 / samedi 2 décembre, 17:30 – Symphonie 2A]
Curvature estimates for semi-convex solutions of Hessian equations

In this talk, we will discuss curvature estimates for Hessian equations with general right hand side. Such equations arise naturally from the study of convex geometry. We will first review the literature of this problem and analyze the difficulty. We will then present our recent work towards this problem.

NICHOLAS MCCLEEREY, Purdue University
[Saturday December 2 / samedi 2 décembre, 17:00 – Symphonie 2A]
Singularities of m-subharmonic Functions

Geometric Partial Differential Equations
Équations géométriques différentielles partielles

We report on some work in progress, concerning measuring the singularities of m-subharmonic functions in $\mathbb{C}^n$ along linear subspaces. We discuss two new quantities, which correspond to the Lelong number and the relative type of Rashkovskii for psh functions. Compared to previous work, our invariants are local in nature.

TRISTAN OZUCH, MIT

[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 2A]

Selfduality along Ricci flow and instabilities of Einstein metrics

Einstein metrics and Ricci solitons are the fixed points of Ricci flow and model the singularities forming. They are also critical points of natural functionals in physics. Their stability in both contexts is a crucial question, since one should be able to perturb away from unstable models.

I will present new results and upcoming directions about the stability of these metrics in dimension four in joint works with Olivier Biquard, and with Keaton Naff. They rely on selfduality, a specificity of dimension four.

MARCIN SROKA, CRM

[Saturday December 2 / samedi 2 décembre, 9:00 – Symphonie 2A]

On the conjecture of Alesker-Verbitsky

We will discuss a geometric PDE, called quaternionic Monge-Ampere equation, introduced 15 years ago by Alesker and Veritsky. This is the equation which solvability is needed for the version of the Calabi conjecture for hypercomplex manifolds to be true. Some new phenomena, regarding higher order estimates, occurs for this equation in comparison to its more classical counterparts of real and complex Monge-Ampere equations. We will focus on outlining this differences.

BRUNO STAFFA, University of Toronto

[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 2A]

Generic density of geodesic nets

Let (M^n, g), $n \geq 2$ be a Riemannian manifold and let Γ be a weighted multigraph. Stationary geodesic nets are embeddings $f : \Gamma \to (M^n, g)$ which are stationary with respect to the length functional induced by the metric g. They arise from Almgren-Pitts Morse theory on the space of 1-cycles $\mathcal{Z}_1(M, g)$ on (M, g). During the talk, we will discuss the following result: for a Baire-generic set of Riemannian metrics on a fixed closed manifold M^n, the union of all stationary geodesic nets is dense in M. This is a joint work with Yevgeny Liokumovich.

FREID TONG, Harvard University

[Saturday December 2 / samedi 2 décembre, 10:00 – Symphonie 2A]

On a free boundary Monge-Ampere equation and complete Calabi-Yau metrics

In this talk, I will discuss a new free-boundary Monge-Ampere equation that arise from the study of complete Calabi-Yau metrics. This is based on joint work with T. Collins and S.-T. Yau.

XINRUI ZHAO, MIT

[Saturday December 2 / samedi 2 décembre, 16:00 – Symphonie 2A]

Unique continuation problem on RCD spaces

In this talk we will sketch the proof of the unique continuation property of harmonic functions and caloric functions on any RCD(K,2) spaces and a counterexample for the strong unique continuation property of harmonic function on an RCD(K,4) space. This characterizes one of the significant differences between RCD spaces and smooth manifolds. We will also talk about some related open problems. The talk is based on joint works with Qin Deng.

Geometry in Calculus of Variations and PDEs

Org: **Lia Bronsard** and/et **Dominik Stantejsky** (McMaster University)

Geometric analysis and calculus of variations has been of great mutual influence that persists until nowadays. Both areas are closely linked to partial differential equations for example via Euler-Lagrange equations or the Noether theorem. Furthermore, they share a large set of common tools and interests that will be presented in this session including the investigation of existence/uniqueness, regularity theory or techniques such as Γ-convergence. Often the considered functionals and equations have a physical interpretation which leads to a large domain of applications, for instance in physics, material science, mechanics and engineering, biology and many more. In order to facilitate the spirited exchange of ideas we plan to invite speakers also from outside Canada. Our choice of speakers reflects the diversity being present in the global mathematical community to promote cross-cultural collaboration.

Schedule/Horaire **Room/Salle: Symphonie 7**

Saturday December 2 **samedi 2 décembre**

8:30 - 9:00	Tiziana Giorgi (University of Alabama), *SmA-type phases of bent-core liquid crystals* (p. 119)
9:00 - 9:30	Dominik Stantejsky (McMaster University), *On Minimizing Harmonic Maps with Planar Boundary Anchoring* (p. 120)
9:30 - 10:00	Kennedy Idu (University of Toronto), *On the Alexandrov's estimate* (p. 120)
10:00 - 10:30	Diane Guignard (University of Ottawa), *Finite Element Methods for the Stretching and Bending of Thin Structures with Folding* (p. 119)

Sunday December 3 **dimanche 3 décembre**

8:30 - 9:00	Xin Yang Lu (Lakehead University), *A physicality-enforcing convex singular potential* (p. 120)
9:00 - 9:30	Lorena Aguirre Salazar (Lakehead University), *On a relationship between the TFDW and the Liquid Drop models via Gamma convergence* (p. 120)
9:30 - 10:00	Jack Tisdell (McGill University), *Minimizing asymptotic score in random bullseye darts for i.i.d. throws* (p. 121)
10:00 - 10:30	Ihsan Topaloglu (Virginia Commonwealth University), *Minimizing sets of weakly-repulsive nonlocal energies* (p. 121)

Abstracts/Résumés

TIZIANA GIORGI, The University of Alabama
[Saturday December 2 / samedi 2 décembre, 8:30 – Symphonie 7]
SmA-type phases of bent-core liquid crystals

We will present some analytical and computational results on the modeling and simulation of polar smectic A phases formed by rigid bent-core molecules. This is joint work with Carlos García-Cervera and Sookyung Joo.

DIANE GUIGNARD, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 10:00 – Symphonie 7]
Finite Element Methods for the Stretching and Bending of Thin Structures with Folding

We study the elastic behavior of prestrained thin plates which can undergo large deformations and achieve non-trivial equilibrium shapes even without external forces. The mathematical problem consists in minimizing an energy of the form $E(\mathbf{y}) = E_S(\mathbf{y}) +$

$\theta^2 E_B(\mathbf{y})$, where $\mathbf{y}$ is the deformation of the midplane, θ is the thickness of the plate, E_S is the (nonconvex) stretching energy, and E_B is the bending energy.

We introduce a discrete energy based on a continuous finite element space and a discrete Hessian operator involving the jump of the gradient of the deformation across the interelement sides. We establish the Γ-convergence of the discrete energy and also present an energy-decreasing gradient flow for finding critical points of the discrete energy. We provide numerical simulations illustrating the capabilities of the model.

This is joint work with A. Bonito and A. Morvant (Texas A&M).

KENNEDY IDU, University of Toronto

[Saturday December 2 / samedi 2 décembre, 9:30 – Symphonie 7]

On the Alexandrov's estimate

A classical fact due to Alexandrov states that if Ω is a bounded open convex domain in $\mathbb{R}^n$, and $u : \bar{\Omega} \to \mathbb{R}$ is a convex function such that $u = 0$ on $\partial\Omega$, then

$$[u]_{1/n}^n \leq C(\Omega)|\partial u(\Omega)|.$$

Here ∂u denotes the subgradient of u. The estimate is not only crucial to regularity theory of the Monge-Ampere equation, but also main tool in some linear elliptic PDE estimates. In this talk, will discuss some extensions and refinements of the estimate using the geometry of $\partial\Omega$. This is a joint work with Charles Griffin and Robert L. Jerrard (University of Toronto).

XIN YANG LU, Lakehead University

[Sunday December 3 / dimanche 3 décembre, 8:30 – Symphonie 7]

A physicality-enforcing convex singular potential

Liquid crystals (LC) are an intermediate state of the matter between solids and liquids, exhibiting significant mobility, but also having a preferred orientation, commonly referred to as "director". LCs themselves exhibit several phases, e.g. nematic, smectic, chiral/twisted, discotic, conic. Nematic LCs are the simplest ones, being characterized by only a director. Modeling LCs has been a long standing problem. One of the most widely models is the Landau-de Gennes theory. In 3D, the main quantity is a 3×3 Q-tensor matrix. Due to modeling requirements, the eigenvalues of the Q-tensor must be constrained in $(-1/3, 2/3)$, a condition known as "physicality". One way to enforce this is to add a singular convex potential ψ, introduced by Ball and Majumdar. Powerful from a theoretical point of view, such ψ is defined only implicitly, as the integral of an entropy-like term, making its analysis quite challenging. In this talk, we will present several crucial estimates on ψ and its derivatives.

LORENA AGUIRRE SALAZAR, Lakehead University

[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 7]

On a relationship between the TFDW and the Liquid Drop models via Gamma convergence

We consider the TFDW model and the Liquid Drop Model with external potential, a model proposed by Gamow in the context of nuclear structure. It has been observed that the TFDW model and the Liquid Drop Model exhibit many of the same properties, especially in regard to the existence and nonexistence of minimizers. We show that, under a "sharp interface" scaling of the coefficients, the TFDW energy with constrained mass Gamma-converges to the Liquid Drop model, for a general class of external potentials. Finally, we present some consequences for global minimizers of each model

---

DOMINIK STANTEJSKY, McMaster University

[Saturday December 2 / samedi 2 décembre, 9:00 – Symphonie 7]

On Minimizing Harmonic Maps with Planar Boundary Anchoring

Motivated by experiments with nematic liquid crystal droplets, we study harmonic maps that arise as minimizers of the the one-constant approximation of the Osee-Frank energy subject to strong anchoring tangential boundary condition. In this talk, I

will present a reflection method allowing us to analyze the regularity of minimizers up to the boundary. We also obtain results on the type and location of defects that can occur, such as boundary "boojums" and interior vortices. The talk is based on joint work with L. Bronsard and A. Colinet.

JACK TISDELL, McGill University
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 7]
Minimizing asymptotic score in random bullseye darts for i.i.d. throws

We present current work—motivated by considerations of the energy of random Voronoi diagrams—on the score in a certain game of darts with both a random bullseye and random throws. We discuss the convergence properties as the number of throws tends to infinity and the asymptotically optimal distribution for the player assuming i.i.d. throws. Curiously, the moments of the score under under optimal play in this sense bear a simple relation to the asymptotically optimal quantizers of the bullseye distribution.

IHSAN TOPALOGLU, VCU
[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 7]
Minimizing sets of weakly-repulsive nonlocal energies

In this talk we will consider weakly repulsive-strongly attractive nonlocal interaction energies over bounded densities of fixed mass m. In particular, we will show that under certain regularity assumptions on the interaction kernels these energies admit minimizers given by characteristic functions of sets volume m when m is sufficiently small (or even for every m, in some cases). Finally, we will present on a generalization of a recent result of Davies, Lim and McCann, and give sufficient conditions that guarantee that minimizers over probability measures are given by Dirac masses concentrated on the vertices of a regular $(N+1)$-gon in $\mathbb{R}^N$. This is a joint work with Davide Carazzato and Aldo Pratelli.

Harmonic Analysis & PDE

Org: Ryan Gibara (University of Cincinnati) and/et **Scott Rodney** (Cape Breton University)

This session will bring together researchers, both junior and senior, who specialize in various subfields of harmonic analysis and the analysis of PDEs. Problems related to a wide range of topics such as Muckenhoupt weights, variable-exponent settings, singular integrals, Bellman functions, rearrangements, potential theory on metric measure spaces, and more, will be considered. The mix of specialties of the intended participants/audience will foster the fruitful exchange of ideas and possible cross-field collaborations.

Schedule/Horaire **Room/Salle: Ovation**

Saturday December 2 samedi 2 décembre

8:30 - 9:00	Paul Gauthier (Université de Montréal), *Radial limits of solutions to elliptic partial differential equations* (p. 123)
9:00 - 9:30	Damir Kinzebulatov (Université Laval), *An Orlicz space dictated by drifts singularities* (p. 124)
9:30 - 10:00	Carrie Clark (University of Illinois Urbana Champaign), *Droplet formation in a simple nonlocal aggregation model* (p. 123)
10:00 - 10:30	Cristian Rios (University of Calgary), *The Moser method for infinitely degenerate equations* (p. 125)
15:00 - 15:30	Aleksander Danielski (Concordia University), *Complex Analytic Structure of Stationary Solutions of the Euler Equations* (p. 123)
15:30 - 16:00	Kirill Golubnichiy (University of Calgary), *Inverse Problem for the Black-Scholes Equation solution.* (p. 123)
16:00 - 16:30	Giangvuthanh Nguyen (Old Dominion University), *Asymptotic expansion of a singular potential near the nematic-isotropic phase transition point in the Landau-de Gennes theory* (p. 124)
16:30 - 17:00	Joshua Flynn (CRM/ISM and McGill University), *LIOUVILLE-TYPE RESULT FOR THE CR YAMABE EQUATION IN THE HEISENBERG GROUP* (p. 123)
17:00 - 17:30	Maria Ntekoume (Concordia University), *Critical well-posedness for the derivative nonlinear Schrödinger equation on the line* (p. 125)
17:30 - 18:00	Cody Stockdale (Clemson University), *On the $T1$ theorem for compactness of Calderón-Zygmund operators* (p. 126)

Sunday December 3 dimanche 3 décembre

8:30 - 9:00	Javad Mashreghi (Université Laval), *A Banach–Steinhaus type theorem* (p. 124)
9:00 - 9:30	Mahishanka Withanachchi (Université Laval), *Polynomial Approximation in Local Dirichlet Spaces* (p. 126)
9:30 - 10:00	Junjie Zhu (University of British Columbia), *Cones are not Salem* (p. 127)
10:00 - 10:30	Leonid Slavin (University of Cincinnati), *Monotone rearrangement and Bellman functions for VMO with generalized Campanato norm* (p. 126)
15:00 - 16:00	Eric Sawyer (McMaster University), *A Proof of the Fourier Restriction Conjecture* (p. 126)
16:00 - 16:30	Ignacio Uriarte-Tuero (University of Toronto), *Some remarks on Muckenhoupt Ap weights* (p. 126)
16:30 - 17:00	Michael Penrod (University of Alabama), *Convolution Operators on Matrix Weighted Variable Lebesgue Spaces* (p. 125)
17:00 - 17:30	Cintia Pacchiano (University of Calgary), *Regularity Results for Double Phase Problems on Metric Measure Spaces* (p. 125)
17:30 - 18:00	Josh Kline (University of Cincinnati), *On regularity of sets of finite fractional perimeter in metric measure spaces* (p. 124)

Harmonic Analysis & PDE

Abstracts/Résumés

CARRIE CLARK, University of Illinois Urbana-Champaign
[Saturday December 2 / samedi 2 décembre, 9:30 – Ovation]
Droplet formation in a simple nonlocal aggregation model

The study of aggregation phenomena in the physical sciences has produced an interesting class of geometric shape optimization problems. One aims to minimize the energy given by a particular interaction kernel. In this talk, we will discuss droplet formation in energy minimizing configurations for a family of interaction kernels which have a "well-barrier" type shape. Short distance attraction, combined with mid distance repulsion, and long distance neutrality drives the formation of droplets.

ALEKSANDER DANIELSKI, Concordia University
[Saturday December 2 / samedi 2 décembre, 15:00 – Ovation]
Complex Analytic Structure of Stationary Solutions of the Euler Equations

This work is devoted to the stationary solutions of the 2D Euler equations describing the time-independent flows of an ideal incompressible fluid. There exists an infinite-dimensional set of such solutions. Prevous authors considered the solutions in the Frechet space of smooth functions and used powerful methods such as the Nash-Moser-Hamilton implicit function theorem to provide a smooth local parameterization of stationary flows in annular domains without stagnation point. However, in their approach they overlook a surprising feature of the stationary flows which makes the picture much more transparent, and opens the way to further progress. This is the observation that the flow lines are analytic curves, despite limited regularity of the velocity field.

To study the stationary flows we change the viewpoint and consider the flow field as a family of analytic flow lines non-analytically depending on parameter. We quantify the analyticity by introducing spaces of functions which have analytic continuation in one of the variables to a complex strip containing the real axis, with appropriate behaviour on the strip boundary. These partially-analytic functions form a complex Banach space. The stationary solutions satisfy (in the new coordinates) a quasilinear elliptic equation, degenerating in the presence of a stagnation point. Local solvability is proved by using the Banach analytic implicit function theorem. Thus we prove that the set of stationary flows is locally a complex analytic Banach manifold.

JOSHUA FLYNN, CRM/ISM, McGill University
[Saturday December 2 / samedi 2 décembre, 16:30 – Ovation]
LIOUVILLE-TYPE RESULT FOR THE CR YAMABE EQUATION IN THE HEISENBERG GROUP

We obtain a Liouville-type result for solutions to the CR Yamabe equation in the Heisenberg group H^n under a pointwise decay assumption at infinity, which extends a result obtained by Jerison and Lee for solutions in $L^{2+2/n}(H^n)$. Our proof relies on integral estimates combined with an extended version of a divergence formula by Jerison and Lee.

PAUL GAUTHIER, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 8:30 – Ovation]
Radial limits of solutions to elliptic partial differential equations

For certain elliptic differential operators L, we study the behaviour of solutions to $Lu = 0$, as we tend to the boundary along radii in strictly starlike domains in $\mathbb{R}^n, n \geq 3$. Analogous results are obtained in other special domains. Our approach involves introducing harmonic line bundles as instances of Brelot harmonic spaces and approximating continuous functions by harmonic functions on appropriate subsets. These approximation theorems on harmonic spaces yield interesting examples for approximation by solutions of $Lu = 0$ on some domains in $\mathbb{R}^n$. Joint work with Mohammad Shirazi.

Harmonic Analysis & PDE

KIRILL GOLUBNICHIY, University of Calgary
[Saturday December 2 / samedi 2 décembre, 15:30 – Ovation]
Inverse Problem for the Black-Scholes Equation solution.

This new technique uses the Black-Scholes equation supplied by new intervals for the underlying stock and new initial and boundary conditions for option prices. The Black-Scholes equation was solved in the positive direction of the time variable, This ill-posed initial boundary value problem was solved by the so-called Quasi-Reversibility Method (QRM). This approach with an added trading strategy was tested on the market data for 368 stock options and good forecasting results were demonstrated. We use the geometric Brownian motion to provide an explanation of that effectivity using computationally simulated data for European call options. We also provide a convergence analysis for QRM. The key tool of that analysis is a Carleman estimate.

DAMIR KINZEBULATOV, Université Laval
[Saturday December 2 / samedi 2 décembre, 9:00 – Ovation]
An Orlicz space dictated by drifts singularities

In a recent paper with Semenov, we established an almost sharp result on weak solvability of singular SDEs. The result is sharp up to the strict inequality in the hypothesis on the magnitude of drift singularities (EJP, 2023). Nothing was known, even at the PDE level, about what happens in the critical case, i.e. when the magnitude of the singularities takes exactly the borderline value. It turns out that the answer lies within a certain Orlicz space. This Orlicz space is essentially dictated by the diffusion equation.

JOSH KLINE, University of Cincinnati
[Sunday December 3 / dimanche 3 décembre, 17:30 – Ovation]
On regularity of sets of finite fractional perimeter in metric measure spaces

Federer's characterization states that a set is of finite perimeter if and only if its measure theoretic boundary has finite codimension 1 Hausdorff measure. In this talk, we discuss the extent to which an analog of this result holds for sets of finite s-perimeter, with $0 < s < 1$, in doubling metric measure spaces. Here the nonlocal s-perimeter is defined via a Besov seminorm, and as shown by Dávila in $\mathbb{R}^n$ and Di Marino and Squassina in the metric setting, recovers the perimeter of a set as $s \to 1^-$ under suitable rescaling. Time permitting, we will also consider a nonlocal minimization problem for the s-perimeter, as introduced by Caffarelli, Roquejoffre, and Savin in $\mathbb{R}^n$, and discuss regularity results for minimizers in the metric setting.

JAVAD MASHREGHI, Laval University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Ovation]
A Banach–Steinhaus type theorem

We introduce the notion of an asymptotically equicontinuous sequence of linear operators, and use it to prove the following result. If X, Y are topological vector spaces, if $T_n, T : X \to Y$ are continuous linear maps, and if D is a dense subset of X, then the following statements are equivalent: (i) $T_n x \to Tx$ for all $x \in X$, and (ii) $T_n x \to Tx$ for all $x \in D$ and the sequence (T_n) is asymptotically equicontinuous.

This is joint work with T. Ransford.

GIANGVUTHANH NGUYEN, Old Dominion University
[Saturday December 2 / samedi 2 décembre, 16:00 – Ovation]
Asymptotic expansion of a singular potential near the nematic-isotropic phase transition point in the Landau-de Gennes theory

Harmonic Analysis & PDE

The Landau-de Gennes theory is a type of continuum theory that describes nematic liquid crystal configurations in the framework of the Q-tensor order parameter. In the free energy, there is a singular bulk potential which is considered as a natural enforcement of a physical constraint on the eigenvalues of symmetric, traceless Q-tensors. In this talk we shall discuss some analytic properties related to this singular potential. More specifically, we study the asymptotic expansion of this singular potential (up to fourth order) near the nematic-isotropic phase transition point.

MARIA NTEKOUME, Concordia University
[Saturday December 2 / samedi 2 décembre, 17:00 – Ovation]
Critical well-posedness for the derivative nonlinear Schrödinger equation on the line

This talk focuses on the well-posedness of the derivative nonlinear Schrödinger equation on the line. This model is known to be completely integrable and L^2-critical with respect to scaling. However, until recently not much was known regarding the well-posedness of the equation below $H^{\frac{1}{2}}$. In this talk we prove that the problem is well-posed in the critical space on the line, highlighting several recent results that led to this resolution. This is joint work with Benjamin Harrop-Griffiths, Rowan Killip, and Monica Visan.

CINTIA PACCHIANO, University of Calgary
[Sunday December 3 / dimanche 3 décembre, 17:00 – Ovation]
Regularity Results for Double Phase Problems on Metric Measure Spaces

In this talk, we present local and global higher integrability properties for quasiminimizers of a class of double-phase integrals characterized by non-standard growth conditions. We work purely on a variational level in the setting of a doubling metric measure space supporting a Poincaré inequality. The main novelty is the use of an intrinsic approach, based on a double-phase Sobolev-Poincaré inequality.

During the past two decades, a theory of Sobolev functions and first degree calculus has been developed in this abstract setting. A central motivation for developing such a theory has been the desire to unify the assumptions and methods employed in various specific spaces, such as weighted Euclidean spaces, Riemannian manifolds, Heisenberg groups, graphs, etc.

Analysis on metric spaces is nowadays an active and independent field, bringing together researchers from different parts of the mathematical spectrum. It has applications to disciplines as diverse as geometric group theory, nonlinear PDEs, and even theoretical computer science. This can offer us a better understanding of the phenomena and also lead to new results, even in the classical Euclidean case.

MICHAEL PENROD, The University of Alabama
[Sunday December 3 / dimanche 3 décembre, 16:30 – Ovation]
Convolution Operators on Matrix Weighted Variable Lebesgue Spaces

The theory of matrix $\mathcal{A}_p$ weights has attracted considerable attention, beginning with the work of Nazarov, Treil, and Volberg in the 1990s. In this talk, we describe our work to extend this theory to the variable Lebesgue spaces. Generalizing matrix $\mathcal{A}_p$ to the variable exponent setting plays a crucial role.

David Cruz-Uribe, Kabe Moen, and Scott Rodney proved that given a matrix weight $W \in \mathcal{A}_p$ and a nice function $\phi \in C_c^\infty(\Omega)$, the convolution operator $\mathbf{f} \mapsto \phi * \mathbf{f}$ is bounded and approximate identities defined using ϕ converge. We extend the convergence of this convolution operator to matrix weighted variable Lebesgue spaces. As an application of our work, we prove a version of the classical H=W theorem for matrix weighted, variable exponent Sobolev spaces.

CRISTIAN RIOS, University of Calgary
[Saturday December 2 / samedi 2 décembre, 10:00 – Ovation]
The Moser method for infinitely degenerate equations

Harmonic Analysis & PDE

We implement the Moser iteration method to obtain boundedness and continuity of solutions to degenerate elliptic equations in which the ellipticity degenerates to infinite order. The degenerate nature of the problem allows the equation to offer a modest improvement for solutions measured in an Orlicz norm that grows slower than any power greater than one. This work is part of an ongoing collaboration with Lyudmila Korobenko, Eric Sawyer and Ruipeng Shen.

ERIC SAWYER, McMaster University
[Sunday December 3 / dimanche 3 décembre, 15:00 – Ovation]
A Proof of the Fourier Restriction Conjecture

We prove the Fourier restriction conjecture. To prove the conjecture, we use frames for Lp consisting of smooth compactly supported Alpert wavelets having a large number of vanishing moments, along with sharp estimates on oscillatory integrals, as part of a two weight testing strategy using pigeonholing via the uncertainty principle.

LEONID SLAVIN, University of Cincinnati
[Sunday December 3 / dimanche 3 décembre, 10:00 – Ovation]
Monotone rearrangement and Bellman functions for VMO with generalized Campanato norm

We consider VMO on an interval equipped with a Campanato-type norm and prove that monotone rearrangement does not increase the norm in this space. This allows us to compute Bellman functions for a family of integral functionals in this setting. Such functions are non-autonomous, in the sense that the length of the interval explicitly enters as one of the three Bellman variables, thus breaking with the method's traditional reliance on scale invariance. This is joint work with Pavel Zatitskii.

CODY STOCKDALE, Clemson University
[Saturday December 2 / samedi 2 décembre, 17:30 – Ovation]
On the $T1$ theorem for compactness of Calderón-Zygmund operators

We give a new formulation of the $T1$ theorem for compactness of Calderón-Zygmund singular integral operators. We prove that a Calderón-Zygmund operator T is compact on $L^2(\mathbb{R}^n)$ if and only if $T1, T^*1 \in \mathrm{CMO}(\mathbb{R}^n)$ and T is weakly compact. Compared to existing compactness criteria, our characterization more closely resembles David and Journé's classical $T1$ theorem for boundedness and follows from a simpler argument.

IGNACIO URIARTE-TUERO, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 16:00 – Ovation]
Some remarks on Muckenhoupt Ap weights

I will present some recently discovered remarks on Muckenhoupt Ap weights, and time permitting, will contextualize their use.

MAHISHANKA WITHANACHCHI, Laval University
[Sunday December 3 / dimanche 3 décembre, 9:00 – Ovation]
Polynomial Approximation in Local Dirichlet Spaces

In this study, we investigate the behavior of partial Taylor sums, denoted as S_n, and Cesàro means (σ_n) within local Dirichlet spaces ($\mathcal{D}_\zeta$), offering a comparative analysis with the classical disc algebra setting. Within the classical disc algebra ($\mathcal{A}$), the precise norm of S_n, commonly known as Lebesgue constants, remains indeterminate, displaying an asymptotic growth rate reminiscent of logarithmic behavior.

Within $\mathcal{D}_\zeta$, we explore various norm definitions, revealing distinct operator norm values for both S_n and σ_n. Our analysis unveils that for S_n, three specific norms exhibit a growth rate approximating $\sqrt{n}$ as n progresses. Notably, we also identify

the existence of functions in $\mathcal{D}_\zeta$ for which the local sequence $\|S_n f\|_{\mathcal{D}_\zeta}$ diverges without bound. Furthermore, it is essential to emphasize that the norms associated with σ_n remain bounded within the context of $\mathcal{D}_\zeta$, highlighting a significant departure from the classical disc algebra setting.

JUNJIE ZHU, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 9:30 – Ovation]
Cones are not Salem

The notions of Hausdorff and Fourier dimensions are ubiquitous in harmonic analysis and geometric measure theory. It is known that any hypersurface in $\mathbb{R}^{d+1}$ has Hausdorff dimension d. However, the Fourier dimension depends on the finer geometric properties of the hypersurface. For instance, the Fourier dimension of a hyperplane is 0, and the Fourier dimension of a hypersurface with non-vanishing Gaussian curvature is d. Recently, Harris has shown that the Euclidean light cone in $\mathbb{R}^{d+1}$ has Fourier dimension $d-1$, which leads one to conjecture that the Fourier dimension of a hypersurface equals the number of non-vanishing principal curvatures. We prove this conjecture for all d-dimensional cones in $\mathbb{R}^{d+1}$ generated by hypersurfaces in $\mathbb{R}^d$ with non-vanishing Gaussian curvature. In particular, cones are not Salem. Our method involves substantial generalizations of Harris's strategy.

Homotopy Theory
Théorie d'homotopie

Org: Martin Frankland (University of Regina) and/et **Chris Kapulkin** (Western University)

"Historically a branch of algebraic topology, homotopy theory is now its own discipline with deep connections to other areas, including algebraic geometry, number theory, geometric topology, category theory, and theoretical computer science, among others. In this special session, we want to bring together researchers working on different aspects of the field: from connections to other disciplines mentioned above, to new results and computations within algebraic topology, to entirely new areas of mathematics inspired by homotopy theory. In addition, we intend this session to be primarily a venue for early career researchers, postdocs, and graduate students to present their results, although we will also invite more senior researchers.

Given the breadth of the field, we will ask all our invitees to prepare talks understandable to all members of the audience, including students and researchers outside of the specialization of the speaker. In particular, talks will clearly present the motivation behind the results. As such, we view this session as being inviting to students and accessible to mathematicians in other fields. We hope that emphasizing understandable talks will help initiate interactions between people working on different aspects of the field, leading to new collaborations. "

Schedule/Horaire **Room/Salle: Symphonie 3A**

Saturday December 2 — samedi 2 décembre

8:00 - 8:30	Peter Bubenik (University of Florida), *Homotopy and persistent homology using closure spaces* (p. 129)
8:30 - 9:00	John Miller (Université de Montréal), *Persistence and Triangulated Categories* (p. 132)
9:00 - 9:30	Udit Mavinkurve (University of Western Ontario), *The Fundamental Group(oid) in Discrete Homotopy Theory* (p. 131)
9:30 - 10:00	Rachel Hardeman Morrill (University of Calgary), *Path Categories and Graphs* (p. 132)
10:00 - 10:30	Toni Annala (Institute for Advanced Study, Princeton), *Topologically protected tricolorings* (p. 129)
15:00 - 15:30	Simon Henry (University of Ottawa), *Simplicial completion of model categories and strictification* (p. 130)
15:30 - 16:00	Daniel Carranza (Johns Hopkins University), *Calculus of fractions for quasicategories* (p. 129)
16:00 - 16:30	Sterling Ebel (University of Western Ontario), *Synthetic approach to the Quillen model structure on spaces* (p. 130)
16:30 - 17:00	Carlos Gabriel Valenzuela (University of Regina), *Double cohomology and sphere triangulations* (p. 133)
17:00 - 17:30	Sacha Ikonicoff (University of Ottawa), *Quillen-Barr-Beck cohomology of divided power algebras over an operad* (p. 131)
17:30 - 18:00	Brandon Doherty (Florida State University), *Cubical Joyal model structures: recent and ongoing developments* (p. 130)

Sunday December 3 — dimanche 3 décembre

8:00 - 8:30	Ben Williams (University of British Columbia), *Looking for extraordinary involutions* (p. 134)
8:30 - 9:00	Arnab Kundu (University of Toronto), *Gersten's injectivity in the non-Noetherian world* (p. 131)
9:00 - 9:30	Elden Elmanto (University of Toronto), *L-functions and algebraic K-theory* (p. 130)
9:30 - 10:00	Kristine Bauer (University of Calgary), *Faa di Bruno for bicategories* (p. 129)
10:00 - 10:30	Dorette Pronk (Dalhousie University), *Double Category Sites for Grothendieck Topoi* (p. 132)
15:00 - 15:30	Nick Rozenblyum (University of Toronto), *Stratifications and reflection* (p. 133)
15:30 - 16:00	Tseleung Larry So (University of Western Ontario), *The cohomology of 4-dimensional toric orbifolds* (p. 133)
16:30 - 17:00	Jerry Wei (University of Toronto), *Analogies of Lie Group Concepts in S^7 and the Space of Commuting Pairs* (p. 134)
17:00 - 17:30	Don Stanley (University of Regina), *Which graded algebras are the cohomology of a space ?* (p. 133)

Homotopy Theory
Théorie d'homotopie

Abstracts/Résumés

TONI ANNALA, Institute for Advanced Study
[Saturday December 2 / samedi 2 décembre, 10:00 – Symphonie 3A]
Topologically protected tricolorings

Topological vortices are codimension-one topological defects that arise in various phys- ical systems, such as liquid crystals, Bose–Einstein condensates, and vacuum structures of Yang–Mills theories. Under certain homotopical assumptions that are satisfied in many realistic systems, topological vortex configurations admit faithful presentations in terms of colored link diagrams. The most well-known coloring scheme of links is given by tricolorings: each arc of the link diagram is colored by one of three possible colors (red, green, or blue) in such a way that, in each crossing, either all arcs have the same color, or all arcs have a different color. A tricolored link is topologically protected if it cannot be transformed into a disjoint union of unlinked simple loops by a sequence of color-respecting isotopies and color-respecting local cut-and-paste operations. The above operations are referred to as topologically allowed local surgeries. We use equivariant bordism groups of three-manifolds to construct invariants of colored links that are conserved in allowed local surgeries, and employ the invariant to classify all tricolored links up to local surgeries. The talk is based on joint work with Hermanni Rajamäki, Roberto Zamora Zamora, and Mikko Möttönen.

KRISTINE BAUER, University of Calgary
[Sunday December 3 / dimanche 3 décembre, 9:30 – Symphonie 3A]
Faa di Bruno for bicategories

The Faà di Bruno formula is the famous formula which allows one to compute the higher derivatives of a composition of functions of a real variable. It can also be used to generalize the chain rule in differential categories (see work of Cockett and Seely, Cruttwell, and Lemay on this topic). There are a few examples of categorical differentiation which involve homotopy, most notably for abelian functor calculus (Bauer, Johnson, Osborne, Riehl and Tebbe 2018) or for infinity categories (Bauer, Burke and Ching, in progress). In this talk, I will explain how the Faa di Bruno construction in differential category theory must be expanded to be used in homotopy theory (specifically in abelian functor calculus). In particular, I will describe a program for obtaining a Faa di Bruno formula for bicategories.

PETER BUBENIK, University of Florida
[Saturday December 2 / samedi 2 décembre, 8:00 – Symphonie 3A]
Homotopy and persistent homology using closure spaces

I will develop homotopy and persistent homology in the setting of filtrations of Cech's closure spaces. Examples of filtrations of closure spaces include metric spaces, weighted directed graphs, and filtrations of topological spaces. Closure spaces have more products and intervals than topological spaces, giving us six homotopy theories, six cubical singular homology theories, and three simplicial singular homology theories. Applied to filtrations of closure spaces, these homology theories produce persistence modules. I will extend the definition of Gromov-Hausdorff distance from metric spaces to filtrations of closure spaces and use it to prove that any persistence module obtained from a homotopy-invariant functor on closure spaces is stable.

This is joint work with Nikola Milicevic.

DANIEL CARRANZA, Johns Hopkins University
[Saturday December 2 / samedi 2 décembre, 15:30 – Symphonie 3A]
Calculus of fractions for quasicategories

Calculus of fractions was introduced by P. Gabriel and M. Zisman in order to study localizations of (1-)categories. From a marked category satisfying calculus of left fractions, they construct a workable model for the localization whose morphisms are

spans, rather than arbitrary zig-zags. Moreover, the localization functor preserves any finite colimits that exist in the original category.

In this talk, I will present a generalization (joint with C. Kapulkin and Z. Lindsey) of calculus of fractions to the setting of quasicategories, and show how a workable model for the localization can be constructed using a marked variant of Kan's Ex-functor. I will also discuss applications of these results to combinatorics in the form of discrete homotopy theory.

BRANDON DOHERTY, Florida State University
[Saturday December 2 / samedi 2 décembre, 17:30 – Symphonie 3A]
Cubical Joyal model structures: recent and ongoing developments

Cubical Joyal model structures, which exhibit cubical sets as a model for the theory of $(\infty, 1)$-categories, were originally developed, and shown to be equivalent to the Joyal model structure on simplicial sets, for categories of cubical sets with faces, degeneracies and connections. In this talk we will discuss the extension of these results to the category of *minimal cubical sets*, having only faces and degeneracies (arXiv:2207.03636). Time permitting, we will also discuss current work in progress on establishing cubical Joyal model structures on categories of cubical sets with diagonals and symmetries.

STERLING EBEL, University of Western Ontario
[Saturday December 2 / samedi 2 décembre, 16:00 – Symphonie 3A]
Synthetic approach to the Quillen model structure on spaces

Quillen's construction of a model structure on the category of topological spaces is a fundamental result in homotopy theory. This construction has since been applied to several related categories, such as k-spaces, and the importance of many model categories is justified by their equivalence with Quillen's structure on spaces.

In this talk, we will present an axiomatic approach to constructing Quillen's model structure on spaces to apply it to a wider range of settings. As special cases we recover several existing model structures, such as on the categories of sober spaces and of pseudotopological spaces. We also use this approach to construct a novel model structure on the category of locales, making the coreflection to sober spaces a Quillen adjunction.

This is joint work with Chris Kapulkin (arXiv:2310.14235).

ELDEN ELMANTO, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 9:00 – Symphonie 3A]
L-functions and algebraic K-theory

Arguably the most influential conjecture in K-theory in the previous century is Quillen-Lichtenbaum's, relating the ratio of even and odd K-groups to special values of the zeta function. This has since been resolved by Voevodsky and Rost, leading to striking development in motivic cohomology and homotopy theory. Dirichlet and Artin L-functions are generalizations of the zeta functions, where one keeps track of an additional character χ of the Galois group. One is then led to ask if these values admit similar K-theoretic interpretations. I will report on joint work with Ningchuan Zhang, where we formulate the twisted variants of the Quillen-Lichtenbaum conjectures, relating the size of K-groups with coefficients in an equivariant Moore spectrum $M(\chi)$ with special values of Artin L-functions, and prove it in some cases. I will focus on the case of finite fields where we obtain the equality:

$$Nm_{\mathbb{Q}[\chi]/\mathbb{Q}} L(-n, \chi) = \frac{\#\pi_{2n}^{C_m}\left(K(\mathbb{F}_{q^m}) \otimes M(\chi)\right)}{\#\pi_{2n-1}^{C_m}\left(K(\mathbb{F}_{q^m}) \otimes M(\chi)\right)} \qquad n \geq 1$$

.

Homotopy Theory
Théorie d'homotopie

SIMON HENRY, uOttawa
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 3A]
Simplicial completion of model categories and strictification

Simplicial completion is a general construction to turn a combinatorial model category into a Quillen equivalent simplicial model category, by considering its category of simplicial objects. It was introduced by Cisinski in the context of Cisinski's model structure, then extended by Dugger to general left proper combinatorial model categories, and it is easy to see that if we accept to work with left semi-model categories, then it can be applied to any combinatorial model category.

But, in fact, simplicial completion can be applied to categories that are not even model categories: Given any presentable category with two cofibrantly generated weak factorization systems, we always obtain a simplicial left semi-model structure on its category of simplicial objects.

Hence an immediate question: If we start with something that doesn't have a well-defined homotopy theory, what is the homotopy theory we get after simplicial completion ? i.e. what does the resulting mode category actually models ? In this talk, we will answer this question and explain how this corresponds to a large generalization of Badzioch's strictification theorem to the setting of infinitary dependently typed theories.

SACHA IKONICOFF, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 17:00 – Symphonie 3A]
Quillen-Barr-Beck cohomology of divided power algebras over an operad

Quillen-Barr-Beck cohomology of divided power algebras over an operad Divided power algebras are algebras equipped with additional monomial operations. They are fairly ubiquitous in the positive characteristic setting, and appear notably in the study of simplicial algebras, in crystalline cohomology, and in deformation theory. An operad is a device that encodes operations: there is an operad for associative algebras, one for commutative algebras, for Lie algebras, Poisson algebras, and so on. Each operad then comes with an associated category of algebras, and also with a category of divided power algebras.

The aim of this talk is to show how André-Quillen cohomology generalises to several categories of algebras using the notion of operad. We will introduce modules and derivations, but also representing objects for modules - known as the universal enveloping algebra - and for derivations - known as the module of Kähler differentials - which will allow us to build an analogue of the cotangent complex. We will see how these notions allow us to recover known cohomology theories on many categories of algebras, while they provide somewhat exotic new notions when applied to divided power algebras.

This is joint work with Martin Frankland and Ioannis Dokas.

ARNAB KUNDU, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 8:30 – Symphonie 3A]
Gersten's injectivity in the non-Noetherian world

Gersten's conjecture predicts that the K-groups of a regular local ring can be calculated by an exact sequence involving the K-groups of its residue fields. As a consequence, we may relate the K-groups of such a ring to its respective Chow groups. In this talk, we report some partial positive results to affirm the predicted injectivity part of this conjecture in a possibly mixed characteristic, non-Noetherian setting. Namely, we give evidence to show that the K-groups of an integral domain that arises as a localisation of a smooth algebra over an equi-characteristic valuation ring of rank 1 inject inside the respective K-groups of its fraction field.

UDIT MAVINKURVE, Western University
[Saturday December 2 / samedi 2 décembre, 9:00 – Symphonie 3A]
The Fundamental Group(oid) in Discrete Homotopy Theory

Homotopy Theory
Théorie d'homotopie

Discrete homotopy theory is a homotopy theory designed for studying simple graphs, detecting combinatorial, rather than topological, "holes." Central to this theory are the discrete homotopy groups, defined using maps out of grids of suitable dimensions. Of these, the discrete fundamental group in particular has found applications in various areas of mathematics, including matroid theory, hyperplane arrangements, and topological data analysis.

In this talk, based on joint work with C. Kapulkin (arxiv:2303.06029), we introduce the discrete fundamental groupoid and use it as a starting point to develop some robust computational techniques. A new notion of covering graphs allows us to extend the existing theory of universal covers to all graphs, and to prove a classification theorem for coverings. We also prove a discrete version of the Seifert-van Kampen theorem, generalizing a previous result of H. Barcelo et al. We then use it to solve the realization problem for the fundamental group through a purely combinatorial construction.

JOHN MILLER, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 8:30 – Symphonie 3A]
Persistence and Triangulated Categories

The relatively new theory of Persistence Modules has seen many applications throughout geometry and topology, in particular in areas of Symplectic Geometry. In 2020 P.Biran, O.Cornea and J.Zhang introduced the notion of triangulated persistence categories (TPCs), a machinery which fits together well the theory of persistence modules with the study of geometric objects via triangulated categories.

It is common for Geometry to give rise to a Triangulated Category. However, we often forget additional data. We can recover some of this using a notion of 'persistence refinements', in which we construct a category with Hom-sets forming persistence modules and which, after localisation by a certain class of morphisms, recovers our original category. Interestingly, the combination of the persistence refinements with the triangulated structure produces a family of (pseudo)metrics on the objects of our category. These metrics and their corresponding topology seem to behave well with the underlying geometry.

The aim of this talk is to give an overview on this subject and to also discuss an algebraic problem motivated by homological mirror symmetry ; how to extend these metrics to the Karoubi completion.

RACHEL HARDEMAN MORRILL, University of Calgary
[Saturday December 2 / samedi 2 décembre, 9:30 – Symphonie 3A]
Path Categories and Graphs

In classical homotopy theory, two spaces are considered homotopy equivalent if one space can be continuously deformed into the other. This theory, however, does not respect the discrete structure of graphs with their vertices and edges. For this reason, a discrete homotopy theory for graphs is needed. A path category is a structure associated to Moore paths and a natural starting place for defining a homotopy theory. In this talk, I will discuss what a path category is, how path categories can be used to define a discrete homotopy theory for graphs, and what kind of structure a path category gives. This work was done in collaboration with Laura Scull and Robin Cockett.

DORETTE PRONK, Dalhousie University
[Sunday December 3 / dimanche 3 décembre, 10:00 – Symphonie 3A]
Double Category Sites for Grothendieck Topoi

In (Cahiers, 2020) DeWolf and I introduce a type of double categories with an Ehresmann topology as sites for étendues. This extends work by Lawson and Steinberg for ordered groupoids: we reinterpret them as double categories and establish a 2-adjunction between the 2-categories of Ehresmann sites and left-cancellative Grothendieck sites. However, since the category of left-cancellative sites does not satisfy the Ore condition for the class of Comparison Lemma maps, we cannot represent geometric morphisms between étendues as a bicategory of fractions for these sites.

In this talk I will introduce a generalization for the notion of Ehresmann site that can be used to represent any Grothendieck topos. The corresponding class of Grothendieck sites is that of the covering-mono sites: sites for which the single arrow

coverages and the monics form an orthogonal factorization system. We show that the Comparison Lemma maps do give a calculus of fractions for this class of sites. The corresponding Ehresmann site double category has covering arrows as horizontal arrows and inclusions of subobjects as vertical arrows. We introduce a notion of covering-flat and covering preserving double functors between these Ehresmann sites with a class of Comparison Lemma double functors, that lets us express geometric morphisms in terms of fractions. This presentation restricts to étendues by only considering the so-called torsion-free generated sites. If time permits I will discuss how this can be used to represent orbifolds. This is joint work with Darien DeWolf (St Francis Xavier University) and Julia Ramos González (UC Louvain).

NICK ROZENBLYUM, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 15:00 – Symphonie 3A]
Stratifications and reflection

I will describe a new duality in homotopy theory called reflection. This duality simultaneously generalizes Greenlees-May duality, the theory of BGP reflection functors giving derived equivalences of quivers, and Lurie's ∞-categorical Dold-Kan correspondence. Moreover, it leads to a categorification of the classical Mobius inversion formula. It is based on a theory of stratified (stable presentable) ∞-categories and is closely related to Verdier duality on stratified spaces. This is joint work with David Ayala and Aaron Mazel-Gee.

TSELEUNG LARRY SO, University of Western Ontario
[Sunday December 3 / dimanche 3 décembre, 15:30 – Symphonie 3A]
The cohomology of 4-dimensional toric orbifolds

A toric orbifold is an even dimensional orbifold formed by gluing tori together in a combinatorial way determined by a simple polytope and a characteristic function. Examples include weighted projective spaces and quasitoric manifolds.

In 2006 Masuda and Suh posed the cohomological rigidity problem: in which class of toric spaces the geometric / topological structures of the spaces are determined solely by their cohomology rings? It has become one of the major and longstanding problems in toric topology. Extensive work has been done to prove an affirmative answer in several smooth cases and to investigate various adaptions of the problem. In the orbifold case, the cohomology rigidity problem is even more challenging and very little is known.

In addition, despite being fundamental objects in toric topology, the cohomology rings of toric orbifolds remain largely unknown except for very few special cases. A central problem is to understand the interplay between their cohomology ring structures and the underlying combinatorial data.

In my presentation I will talk about my joint projects on the cohomological rigidity and the cohomology ring structures of 4-dimensional toric orbifolds.

This is joint work with Xin Fu (Beijing Institute of Mathematical Sciences and Applications) and Jongbaek Song (Pusan National University).

DON STANLEY
[Sunday December 3 / dimanche 3 décembre, 17:00 – Symphonie 3A]
Which graded algebras are the cohomology of a space?

This is an old problem sometimes called Steenrod's problem. Important examples include Hopf invariant 1 resolved by Adams and a complete solutions over the rationals by Quillen. We describe some recent progress on the problem for algebras over the integers that become (graded) exterior after tensoring with the rationals. This is joint work with Larry So and Stephen Theriault.

Homotopy Theory
Théorie d'homotopie

CARLOS GABRIEL VALENZUELA, University of Regina
[Saturday December 2 / samedi 2 décembre, 16:30 – Symphonie 3A]
Double cohomology and sphere triangulations

Given a simplicial complex $\mathcal{K}$ it's of general interest to study it's moment-angle complex $\mathcal{Z}_{\mathcal{K}}$, particularly in toric topology. In 2020, Limonchenko, Panov, Stanley and Song designed a new homological invariant for $\mathcal{Z}_{\mathcal{K}}$ called the double (co)homology. This invariant is less chaotic by design than the regular (co)homology of $\mathcal{Z}_{\mathcal{K}}$ which can be of interest for applications. It remains an unsolved problem whether this new (co)homology theory can be of any prescribed rank.

In my work I've been studying sphere triangulations and how their associated double cohomology behaves under operations to them. These are particularly interesting, as their double cohomology is a Poincare Algebra. Furthermore, these complexes turn out to be a good starting point for constructing complexes with exotic double homology rank.

During the talk I'll introduce the construction of double homology and present some recent results about it.

JERRY WEI, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 16:30 – Symphonie 3A]
Analogies of Lie Group Concepts in S^7 and the Space of Commuting Pairs

The octonions, also known as Cayley numbers, has a norm-preserving multiplication. The unit octonions S^7 is an H-space which is not a Lie group due to failure of associativity. We examine the extent to which S^7 does or does not have analogies to Lie group concepts such as maximal torus, Weyl group, etc. Moreover, we give an explicit description of the centralizer of elements of S^7 and use it to compute the homology of the space of commuting pairs $\{(x, y) \in S^7 \times S^7 : xy = yx\}$.

BEN WILLIAMS, UBC
[Sunday December 3 / dimanche 3 décembre, 8:00 – Symphonie 3A]
Looking for extraordinary involutions

If X is a topological space with a self-map $\lambda : X \to X$ of order 2 and A is a bundle of matrix algebras (a topological Azumaya algebra) over X, then a λ-involution of A is an isomorphism of bundles of algebras $\sigma : A \to \lambda^* A^{\mathrm{op}}$. The structure (A, σ) may be locally isomorphic to a trivial algebra $\mathrm{Mat}_{n\times n}(\mathbb{C}) \times X$ with some involution, in which case σ is said to be of ordinary type. In this talk, I will explain the algebraic topology underlying the construction of more exotic examples of involutions.

Mathematical, statistical, and AI modelling of Mpox and related diseases. Modélisation mathématique, statistique et IA du Mpox et des maladies associées

Org: Nasri Bouchra (Université de Montréal) and/et **Woldegerima Assefa Woldegebriel** (York University)

Increased interactions between humans and animals present ideal environments for the (re)emergence and transmission of zoonotic origin pathogens, such as mpox. Sexual contact has been hypothesized as the primary transmission route for the disease in the recent outbreak, with the community of Gay, bisexual, and men having sex with men (gbMSM) disproportionately affected. Initially, mpox was predominantly zoonotic, with an animal-to-human transmission, throughout the last decades, however, human-to-human transmission has become more sustained in recent years. The recent 2022 mpox outbreak, has unusual epidemiological and clinical features compared with previous outbreaks. This clearly indicates that the world needs to pay more attention to this disease and other zoonotic threats. Disease modelling approaches using mathematical, statistical, and AI have played a central role during epidemics and pandemics, providing a cost-effective way of assessing disease transmission as well as targets for preventing disease and control. This session will bring together researchers working on mathematical, statistical, and machine learning modelling and Prediction of epidemiological dynamics and other socioeconomic, and behavioural factors related to mpox or other related infectious diseases. This session will also serve as a platform for junior and senior researchers to exchange new ideas and initiate potential collaborations.

Schedule/Horaire **Room/Salle: UQAM - PK-3205**

Sunday December 3 **dimanche 3 décembre**

8:30 - 9:00	Bouchra Nasri (Université de Montréal), *Mathematical modeling of mpox: a scoping review* (p. 136)
9:00 - 9:30	Iain Moyles (York), *Bifurcations in fear behaviour impact final-size in a disease epidemic* (p. 136)
9:30 - 10:00	Jhoana P. Romero-Leiton (University of Manitoba), *Mathematical modelling of the first HIV/ZIKV co-infection cases in Colombia and Brazil* (p. 136)
10:00 - 10:30	Woldegebriel Assefa Woldegerima (York), *Quantifying the Basic Reproduction Number and the Underestimated Fraction of Mpox Cases: Mathematical Modelling and ML Study* (p. 137)
15:00 - 15:30	Jacques Bélair (Université de Montréal), *Modeling Variable Compliance to Recommended Interventions to Control Outbreaks* (p. 135)
15:30 - 16:00	Qing Han (York) (p. 136)
16:00 - 16:30	Jude Kong (York) (p. 136)
16:30 - 17:00	Idriss Sekkak (Université de Montréal), *An analysis of a Multigroup mpox epidemic model incorporating public health measures* (p. 137)

Abstracts/Résumés

AZADEH AGHAEEYAN, Brock
[UQAM - PK-3205]

JACQUES BÉLAIR, Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 15:00 – UQAM - PK-3205]
Modeling Variable Compliance to Recommended Interventions to Control Outbreaks

Management of the COVID-19 pandemic required, during its early stages, the deployment of non pharmaceutical interventions (NPIs) [social isolation, physical distancing, mask-wearing, hand-washing], and then, as they became available, administration of repeated doses of vaccine. We are interested in the consequences, for the dynamics of the disease, of variable adherence to

these measures, and the motivation generating the lack thereof ; so we investigate a model for the change in attitude post-infection. A basic SEIRS model is expanded by a. introducing a structure in the infectious class, to reflect the variable severity of symptoms and the presence of asymptomatic cases ; and b. considering the population divided into two classes according to their degree of adherence to the NPIs. Analysis of the ensuing model is guided by epidemiological observations in Québec. A recent analysis of a simpler model for compliance pre-infection will be presented.

QING HAN, York
[Sunday December 3 / dimanche 3 décembre, 15:30 – UQAM - PK-3205]

JUDE KONG, York
[Sunday December 3 / dimanche 3 décembre, 16:00 – UQAM - PK-3205]

IAIN MOYLES, York University
[Sunday December 3 / dimanche 3 décembre, 9:00 – UQAM - PK-3205]
Bifurcations in fear behaviour impact final-size in a disease epidemic

We explore a mathematical model of disease transmission with a fearful compartment. Susceptible individuals become afraid by either interacting with individuals who are already afraid or those who are infected. Individuals who are afraid take protective measures via contact reductions to reduce risk of transmission. Individuals can lose fear naturally over time or because they see people recovering from the disease. We consider two scenarios of the model, one where fear is obtained at a slower rate than disease spread and one where it is comparable. In the former we show that behavioural change cannot impact disease outcome, but in the latter, we observe that sufficient behavioural intervention can reduce disease impact. However, response to recovery can induce a bifurcation where contact reduction cannot mitigate disease spread. We identify this bifurcation and demonstrate its implication on disease dynamics and final size.

BOUCHRA NASRI, Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 8:30 – UQAM - PK-3205]
Mathematical modeling of mpox: a scoping review

Mpox, a disease that was formerly found in Africa, saw its global epidemic in 2022 and has since spread to several other parts of the world, posing a threat to global public health. The application of appropriate mathematical modelling techniques is required for well-informed policies intended to manage and control the spread of this disease. To identify the model classes that are most frequently used, their underlying assumptions, and the modelling shortcomings that need to be addressed in light of the epidemiological features of the current mpox outbreak, we will discuss mathematical models that have been used to study mpox transmission in the literature in this talk. This is a joint work with Jeta Molla, Idriss Sekkak, Ariel Mundo Ortiz, Iain Moyles.

JHOANA P. ROMERO-LEITON, University of Manitoba
[Sunday December 3 / dimanche 3 décembre, 9:30 – UQAM - PK-3205]
Mathematical modelling of the first HIV/ZIKV co-infection cases in Colombia and Brazil

In this work, we present a mathematical model to investigate co-infection with HIV/AIDS and zika virus (ZIKV) in Colombia and Brazil, where the first cases were reported in 2015-2016. The model considers the sexual transmission dynamics of both viruses and vector-host interactions. We begin by exploring the qualitative behaviour of each model separately. Then, we analyze the dynamics of the co-infection model using the thresholds and results defined separately for each model. The model also considers the impact of intervention strategies, such as, personal protection, antiretroviral therapy (ART), and sexual

protection. Using available parameter values for Colombia and Brazil, the model is calibrated to predict the potential effect of the intervention strategies on the co-infection spread. According to these findings, transmission through sexual contact is a determining factor in the long-term behaviour of these two diseases. Furthermore, it is noted that co-infection with HIV and ZIKV may result in higher rates of HIV transmission and an increased risk of severe congenital disabilities linked to ZIKV infection. As a result, control measures have been implemented to limit the number of infected individuals and mosquitoes, with the aim of halting disease transmission. This study provides novel insights into the dynamics of HIV/ZIKV co-infection and highlights the importance of integrated intervention strategies in controlling the spread of these viruses, which may impact public health.

Keywords: Stability, Equilibrium points, Optimal control, Personal protection, Sexual protection, Antiretroviral therapy.

Co-authors: Idriss Sekkak (University of Montreal), Julien Arino (University of Manitoba), Bouchra Nasri (University of Montreal).

IDRISS SEKKAK, École de santé publique de l'Université de Montréal
[Sunday December 3 / dimanche 3 décembre, 16:30 – UQAM - PK-3205]
An analysis of a Multigroup mpox epidemic model incorporating public health measures

Epidemiological models help researchers and public health officials understand the dynamics of infectious diseases, predict their spread, and plan effective intervention strategies. For this matter, an analysis of a mpox epidemic model with heterogeneous mixing is conducted by incorporating several functions and parameters that model public health measures. Our analysis focuses on investigating how various public health measures, such as vaccination campaigns, and quarantine protocols, influence the spread of mpox within and between these population groups. Consequently, we investigate the proposed dynamical systems through both analytical and numerical methods in order to shed light on the effectiveness of these measures in mitigating the mpox epidemic across diverse demographic segments.

WOLDEGEBRIEL ASSEFA WOLDEGERIMA, York University
[Sunday December 3 / dimanche 3 décembre, 10:00 – UQAM - PK-3205]
Quantifying the Basic Reproduction Number and the Underestimated Fraction of Mpox Cases: Mathematical Modelling and ML Study

The current global outbreak of mpox, which started in April 2022 has different epidemiological and clinical features compared to previous mpox outbreaks. Sexual contact has been hypothesized as the major transmission route for the disease in this outbreak, with the community of men having sex with men (MSM) disproportionately and dramatically affected. To better understand the transmission dynamics of the disease, it is essential to understand its dynamics during the early stages of the outbreak. In this article, we estimate the basic reproduction number and the ascertainment fraction of the reported cases of mpox around the world. We divide the population of each country into two groups (high-risk and low-risk groups) and consider two routes of transmission: sexual and non-sexual. Our estimate of the basic reproduction number of mpox in the considered countries ranges between 1.37 (Canada) and 3.68 (Germany). Furthermore, our estimates of the ascertainment fraction for the reported cases of mpox show a large variation in the under-reporting of cases in the high-risk population around the world with ascertainment fractions between 0.25 and 0.93, and a more consistent ascertainment fraction for the low-risk population, which ranges from 0.65 to 0.85. Our estimates can help public health decision- and policymakers better understand the mpox outbreak, in terms of how many underestimated cases can occur in several countries, and how the epidemic can spread differently.

Mathematics in the Public Sector

Org: Megan Dewar (Tutte Institute for Mathematics and Computing) and/et **Kseniya Garaschuk** (Canadian Centre for Cyber Security)

In this session, we will highlight the mathematical research that is performed in Canadian government organizations and the public sector. The presentations will showcase techniques in cryptography, cybersecurity, data science, mathematical modelling, and numerical analysis from both a practical and theoretical perspective. The speakers will represent a variety of public sector institutions, including Statistics Canada, the Bank of Canada, the National Research Council Canada, the Department of National Defence, and Communications Security Establishment.

Schedule/Horaire **Room/Salle: UQAM - PK-6605**

Saturday December 2 **samedi 2 décembre**

8:30 - 9:00	Benoit Hamelin (Tutte Institute for Mathematics and Computing), *Telemetry representation and interactive labeling to facilitate cyber defense* (p. 138)
9:00 - 9:30	Sichun Wang (Defence Research and Development Canada), *Miscellaneous Applications of Mathematics and Statistics in Statistical Signal Processing and White-Box Cryptography* (p. 140)
9:30 - 10:00	Masoud M Nasari (Bank of Canada), *Disaggregating low-frequency economic measures* (p. 139)
10:00 - 10:30	Question and Answer Period (p. 139)
15:00 - 15:30	Koray Karabina (National Research Council Canada), *Cryptography Meets Topological Data Analysis* (p. 138)
15:30 - 16:00	Mark Rempel (Defence Research and Development Canada), *Practical applications of reinforcement learning for decision support in defence and security* (p. 139)
16:00 - 16:30	Valérie Poulin (Tutte Institute for Mathematics and Computing/Applied Research at Communications Security Establishment), *Hypergraph exploration via vectorization* (p. 139)
16:30 - 17:00	Benjamin Santos (Statistics Canada), *Multi-Party Privacy Preserving Record Linkage based on Circuit Private Set Intersection* (p. 140)
17:00 - 17:30	Question and Answer Period (p. 139)

Abstracts/Résumés

BENOIT HAMELIN, Tutte Institute for Mathematics and Computing
[Saturday December 2 / samedi 2 décembre, 8:30 – UQAM - PK-6605]
Telemetry representation and interactive labeling to facilitate cyber defense

Cyber defense processes involve the processing and analysis of large volumes of telemetry data. Many phenomena of interest are described over tangled subsequences of telemetry streams, and cyber analysts experience difficulty making out the data patterns that drive their investigations. Behaviours over telemetry streams form a heavy-tailed distribution, precluding the proxy approach of anomaly detection ; and there exists no labeling information to discern patterns of interest. This work presents tools for the interactive annotation of such collective telemetry phenomena by characterizing them from mutual similarity and time persistence. The annotation process and outcome is demonstrated through the example of host-based sensor telemetry.

KORAY KARABINA, National Research Council of Canada
[Saturday December 2 / samedi 2 décembre, 15:00 – UQAM - PK-6605]
Cryptography Meets Topological Data Analysis

Mathematics in the Public Sector

Topological Data Analysis (TDA) offers a suite of computational tools that provide quantified shape features in high-dimensional data, which can be utilized by modern statistical and predictive machine learning models. In particular, persistent homology (PH) takes in data and derives compact representations of latent topological structures, known as persistence diagrams. PH has been widely adopted for model development on sensitive data, motivating the computation of PH on encrypted data. In this presentation, I will provide brief introductions to TDA and secure computing and then demonstrate how to modify the boundary matrix reduction algorithm to compute PH on encrypted data using homomorphic encryption.

MASOUD M NASARI, Bank of Canada
[Saturday December 2 / samedi 2 décembre, 9:30 – UQAM - PK-6605]
Disaggregating low-frequency economic measures

Having access to high-frequency economic measures is essential for making informed decisions and understanding economic trends in real-time. These measures, such as the Gross Domestic Product (GDP), are not always available at a desired high-frequency. For example, the GDP for Canadian regions is available only annually. A method of disaggregating the annual GDP of the regions to estimate their quarterly and monthly values will be presented in this talk. The results will, in turn, be used for nowcasting and forecasting future values of the high-frequency regional GDP

VALÉRIE POULIN, Tutte Institute for Mathematics and Computing (CSE)
[Saturday December 2 / samedi 2 décembre, 16:00 – UQAM - PK-6605]
Hypergraph exploration via vectorization

Representing data in a relational manner has become a very common decision for analyzing data sets. In some situations, hypergraph structures are preferred over graphs as they allow for capturing more complex relationships amongst objects. In this work, we present a joint vertex and hyperedge vectorization strategy. The joint vectorization we propose is performed in two steps. We first create vertex vectors based on co-occurrences of vertices in hyperedges. Once vertices are embedded in a space, we consider each hyperedge as a distribution over the vertex space and define a hyperedge distance using a distribution metric. The distance between hyperedges is therefore not limited to the intersection size: two non-overlapping hyperedges can end up being similar if the vertices they contain are.

Through a concrete example we demonstrate how this vectorization allows for visual exploration, cluster interpretation and much more. This analytical framework perfectly illustrates what guides unsupervised data science research at the Institute.

QUESTION AND ANSWER PERIOD,
[Saturday December 2 / samedi 2 décembre, 10:00 – UQAM - PK-6605]

QUESTION AND ANSWER PERIOD,
[Saturday December 2 / samedi 2 décembre, 17:00 – UQAM - PK-6605]

MARK REMPEL, Defence Research and Development Canada
[Saturday December 2 / samedi 2 décembre, 15:30 – UQAM - PK-6605]
Practical applications of reinforcement learning for decision support in defence and security

Sequences of decisions that occur under uncertainty arise in a variety of settings, including transportation, communication networks, finance, defence, etc. The classic approach to find an optimal decision policy for a sequential decision problem is dynamic programming ; however its usefulness is limited due to the curse of dimensionality and the curse of modelling, and thus many real-world applications require an alternative approach. Given its success in recent years, Reinforcement Learning (RL) has gained popularity as an approach to solve these types of problems. In addition, in the field of operations research,

Mathematics in the Public Sector

Powell's recently published unified framework for sequential decisions provides a methodology that links mathematical modelling, stochastic optimization, approximate dynamic programming, RL, simulation, as well as other related fields with the aim to model and solve sequential decision problems. In this talk we discuss two recent decision support applications—mass evacuation in the Arctic, and capital investment planning—that focus on using Powell's framework and RL concepts within defence and security. Lastly, ongoing activities within a newly formed NATO research task group that is focused on RL-based decision support will be highlighted.

BENJAMIN SANTOS, Statistics Canada

[Saturday December 2 / samedi 2 décembre, 16:30 – UQAM - PK-6605]

Multi-Party Privacy Preserving Record Linkage based on Circuit Private Set Intersection

Record Linkage (RL) is the process of combining information about entities in multiple data sources into a single linked dataset. In some linkages, the desired output is not the linked data itself, but a set of aggregates based on the cross-linked dataset, such as, aggregated tables. In our previous work [1], we designed and implemented a protocol for Privacy-Preserving RL (PPRL) with aggregation based on Oblivious Programmable Pseudo-Random Functions (OPPRFs) and Secure Multi-Party Computation (SMPC). This protocol allows two parties with datasets, e.g., a National Statistical Office (NSO) and a Government Agency (GA), to obtain weighted aggregates based on values present in the intersection of both datasets while ensuring privacy in a semi-honest scenario. The goal is to extend it to more than two parties, i.e., Multi-Party PPRL (MP-PPRL). This is a natural extension since parties could be playing the role of an NSO, GAs, regional and/or private partners. We based our work on Chandran et al. [2], that implements Relaxed Batch OPPRFs and SMPC to build a protocol for Circuit Private Set Intersection, which we extended to MP-PPRL. We found that the multi-party extension to PPRL is more complex and stiffer, meaning the solution must be tailored to the problem of study: datasets and aggregations.

 References

 [1] Dugdale, et al. Practical Privacy-Aware Data Linkage and Statistical Aggregation based on Privacy Enhancing Techniques. CROSS-NTTS 2023.

 [2] Chandran, et al. Efficient Linear Multiparty PSI and Extensions to Circuit/Quorum PSI. Proceedings of the 2021 ACM SIGSAC CCCS.

SICHUN WANG, Defence Research and Development Canada

[Saturday December 2 / samedi 2 décembre, 9:00 – UQAM - PK-6605]

Miscellaneous Applications of Mathematics and Statistics in Statistical Signal Processing and White-Box Cryptography

Mathematics and statistics are not only essential in natural and social sciences, computer science, medicine and finance but also indispensable in a vast array of practical industrial engineering applications, such as error control coding in wireless communications, data encryption and user authentication in cybersecurity and spacecraft orbit determination for global navigation satellite systems (GNSS). Resolution of mathematical problems arising from various engineering applications presents unique challenges and often requires a combination of engineering insights and sophisticated techniques and tools from mathematics, statistics, numerical analysis and computer science. In this talk, we use real examples to illustrate how engineering problems can be solved by finding solutions to their mathematical/statistical models. More specifically, we shall touch upon the following three topics:

(1) Numerical computation of the normalized detection threshold for FFT filter bank-based signal detection schemes in civilian spectrum monitoring and military radio surveillance. (2) Construction of permutation polynomials on the ring of integers modulo n and their applications in turbo codes, software obfuscation and protection, and white-box cryptography. (3) Geolocation of COSPAS-SARSAT emergency search and rescue beacons.

During the talk, open problems motivated by these three applications will also be briefly discussed.

Mathematics of Machine Learning
Les mathématiques de l'apprentissage automatique

Org: Ben Adcock (SFU), **Jason Bramburger** (Concordia), **Giang Tran** (Waterloo) and/et **Hamid Usefi** (Memorial)

Machine learning is having a profound impact on many different sectors including scientific research, industry, and policymaking. Yet, its mathematical foundations are still far from being well understood. While techniques such as deep learning have produced outstanding success on a wide range of real-world applications, it is increasingly well known that such methods may exhibit unpredictable performance or instabilities, and generally lack interpretability. Moreover, although stochastic optimization algorithms are ubiquitous in machine learning, their convergence properties are still not fully understood in the nonconvex framework. These and other gaps between theory and practice raise the pressing need for a broader, more comprehensive mathematical foundations for machine learning. This session will mark the fifth in a series of sessions at CMS meetings on this theme. Topics include (but are not limited to): deep learning, explainability and interpretability of deep neural networks, natural language processing, feature selection and dimensionality reduction, classification and regression, optimization methods for machine learning. Its aim is to bring together a diverse group of leading experts in mathematics of machine learning. The proposed session will be a forum for discussing and exploring emerging ideas in this fast-growing and exciting field.

Schedule/Horaire — Room/Salle: Soprano A

Saturday December 2 — samedi 2 décembre

9:00 - 9:30	Simone Brugiapaglia (Concordia University), *Generalization limits of deep neural networks in identity effects learning* (p. 142)
9:30 - 10:00	Adam Gardner (Artinus Consulting), *Decoding Neural Scaling Laws* (p. 143)
10:00 - 10:30	Luana Ruiz (Johns Hopkins University), *Machine Learning on Large-Scale Graphs* (p. 144)
15:00 - 15:30	Mark Iwen (Michigan State University), *Sparse Spectral Methods for Solving High-Dimensional and Multiscale Elliptic PDEs* (p. 143)
15:30 - 16:00	Wenjing Liao (Georgia Institute of Technology), *Exploiting low-dimensional structures in machine learning and PDE simulations* (p. 143)
16:00 - 16:30	Serge Prudhomme (Polytechnique Montreal), *Reduced-order modeling for the wave equation using Green's functions and neural networks* (p. 144)
16:30 - 17:00	Christoph Ortner (University of British Columbia), *Efficient Parameterization of Many-body Interaction* (p. 144)
17:00 - 17:30	Ziad Aldirany (Polytechnique Montreal), *Multi-Level Approach for Error Reduction in Physics-Informed Neural Networks* (p. 141)
17:30 - 18:00	Philippe-André Luneau (Université Laval), *Conservative Surrogate Models for Optimization with the Active Subspace Method* (p. 143)

Sunday December 3 — dimanche 3 décembre

9:00 - 9:30	Elina Robeva (University of British Columbia), *Learning Causal Models via Algebraic Constraints* (p. 144)
9:30 - 10:00	Elizabeth Collins-Woodfin (McGill), *High dimensional limit of streaming SGD for generalized linear models* (p. 142)
10:00 - 10:30	Matthew Scott (McGill University), *When are generative models suitable for signal recovery from subsampled Fourier measurements ?* (p. 145)

Abstracts/Résumés

Mathematics of Machine Learning
Les mathématiques de l'apprentissage automatique

ZIAD ALDIRANY, Polytechnique Montréal
[Saturday December 2 / samedi 2 décembre, 17:00 – Soprano A]
Multi-Level Approach for Error Reduction in Physics-Informed Neural Networks

In recent years, deep learning approaches, such as the physics-informed neural networks (PINNs), have shown promising results for several classes of initial and boundary-value problems. However, their ability to surpass, particularly in terms of accuracy, classical discretization methods such as the finite element methods, remains a significant challenge. One of the main obstacles of deep learning approaches lies in their inability to consistently reduce the relative error in the computed solution. We present our novel approach, the multi-level neural networks, in order to reduce the solution error when using deep learning approaches. The main idea consists in computing an initial approximation to the problem using a simple neural network and in estimating, in an iterative manner, a correction by solving the problem for the residual error with a new network of increasing complexity. This sequential reduction of the residual associated with the partial differential equation allows one to decrease the solution error, which, in some cases, can be reduced to machine precision. The underlying explanation is that the method is able to capture at each level smaller scales of the solution using a new network. Numerical examples in 1D and 2D dealing with linear and non-linear problems are presented to demonstrate the effectiveness of the proposed approach using PINNs.

SIMONE BRUGIAPAGLIA, Concordia University
[Saturday December 2 / samedi 2 décembre, 9:00 – Soprano A]
Generalization limits of deep neural networks in identity effects learning

A key open problem in the mathematical foundations of deep learning is understanding *generalization*, informally defined as the ability of neural networks to successfully perform a given task outside the training set. Motivated by this challenge and by applications to cognitive science, we consider the problem of learning *identity effects*, i.e., classifying whether a pair of objects is identical or not, and present a theory aimed at rigorously identifying the generalization limits of deep learning for this task.

First, we will illustrate a general *rating impossibility* theorem that identifies settings where machine learning algorithms are provably unable to generalize outside the training set. Then, we will show how to apply this theorem to popular deep learning architectures such as feed-forward, recurrent and graph neural networks trained via stochastic gradient descent or Adam. For graph neural networks, we will also present a *rating possibility* theorem that establishes sufficient conditions for the existence of architectures able to generalize outside the training set. Finally, we will illustrate numerical experiments that either validate our theoretical findings or identify gaps between theory and practice.

This presentation is based on joint work with Giuseppe A. D'Inverno, Matthew Liu, Mirco Ravanelli, and Paul Tupper.

ELIZABETH COLLINS-WOODFIN, McGill University
[Sunday December 3 / dimanche 3 décembre, 9:30 – Soprano A]
High dimensional limit of streaming SGD for generalized linear models

We provide a characterization of the high dimensional limit of one-pass, single batch stochastic gradient descent (SGD) in the case where the number of samples scales proportionally with the problem dimension. We characterize the limiting process in terms of its convergence to a high-dimensional stochastic differential equation, referred to as the homogenized SGD. Our proofs assume Gaussian data but allow for a very general covariance structure. Our set-up covers a range of optimization problems including linear regression, logistic regression, and some simple neural nets. For each of these models, the convergence of SGD to homogenized SGD enables us to derive a close approximation of the statistical risk (with explicit and vanishing error bounds) as the solution to a Volterra integral equation. In a separate paper, we perform similar analysis without the Gaussian assumption in the case of SGD for linear regression. (Based on joint work with C. Paquette, E. Paquette, I. Seroussi).

Mathematics of Machine Learning
Les mathématiques de l'apprentissage automatique

MAIA FRASER, University of Ottawa
[Soprano A]

ADAM GARDNER, Artinus Consulting Inc.
[Saturday December 2 / samedi 2 décembre, 9:30 – Soprano A]
Decoding Neural Scaling Laws

For a large variety of models and datasets, neural network performance has been empirically observed to scale as a power-law with model size and dataset size. We will explore the origins of these scaling laws and their relationship to geometric proprieties such as the dimension of the data manifold and symmetries shared by the model and dataset. While the takeaway from these scaling laws for many prominent artificial intelligence labs is to improve performance by increasing model and dataset sizes, we propose an alternative perspective - a deeper mathematical understanding of these scaling laws will help researchers discover more efficient neural network architectures. We conclude with some potential future directions for this line of research.

MARK IWEN, Michigan State University
[Saturday December 2 / samedi 2 décembre, 15:00 – Soprano A]
Sparse Spectral Methods for Solving High-Dimensional and Multiscale Elliptic PDEs

In his monograph "Chebyshev and Fourier Spectral Methods", John Boyd claimed that, regarding Fourier spectral methods for solving differential equations, "[t]he virtues of the Fast Fourier Transform will continue to improve as the relentless march to larger and larger [bandwidths] continues". This talk will discuss attempts to further the virtue of the Fast Fourier Transform (FFT) as not only bandwidth is pushed to its limits, but also the dimension of the problem. Instead of using the traditional FFT however, we make a key substitution from the sublinear-time compressive sensing literature: a high-dimensional, sparse Fourier transform (SFT) paired with randomized rank-1 lattice methods. The resulting sparse spectral method rapidly and automatically determines a set of Fourier basis functions whose span is guaranteed to contain an accurate approximation of the solution of a given elliptic PDE. This much smaller, near-optimal Fourier basis is then used to efficiently solve the given PDE in a runtime which only depends on the PDE's data/solution compressibility and ellipticity properties, while breaking the curse of dimensionality and relieving linear dependence on any multiscale structure in the original problem. Theoretical performance of the method is established with convergence analysis in the Sobolev norm for a general class of nonconstant diffusion equations, as well as pointers to technical extensions of the convergence analysis to more general advection-diffusion-reaction equations. Numerical experiments demonstrate good empirical performance on several multiscale and high-dimensional example problems, further showcasing the promise of the proposed methods in practice.

WENJING LIAO, Georgia Institute of Technology
[Saturday December 2 / samedi 2 décembre, 15:30 – Soprano A]
Exploiting low-dimensional structures in machine learning and PDE simulations

Many data in real-world applications are in a high-dimensional space but exhibit low-dimensional structures. In mathematics, these data can be modeled as random samples on a low-dimensional manifold. I will talk about machine learning tasks like regression and classification, as well as PDE simulations. We consider deep learning as a tool to solve these problems. When data are sampled on a low-dimensional manifold, the sample complexity crucially depends on the intrinsic dimension of the manifold instead of the ambient dimension of the data. Our results demonstrate that deep neural networks can utilize low-dimensional geometric structures of data in machine learning and PDE simulations.

PHILIPPE-ANDRÉ LUNEAU, Université Laval
[Saturday December 2 / samedi 2 décembre, 17:30 – Soprano A]
Conservative Surrogate Models for Optimization with the Active Subspace Method

A way to enforce with high probability nonlinear constraints for optimization using the Active Subspace (AS) method is proposed. The goal of using AS is to lower the dimension of the parametric space of the objective function, reducing effects related to the curse of dimensionality. Generally, this method relies on low-dimensional surrogate models of the objective and the constraints over the AS. Unfortunately, since the surrogate constraints are inexact, this can make the resulting optimal solutions infeasible with respect to the exact constraints. To counter this, an artificial bias is imposed on the training data of the surrogate over the active subspace. Two approaches are proposed to determine the bias: the first one using resampling by bootstrap, and the second one using concentration inequalities. To alleviate the computational cost of bootstrapping, the training data is itself resampled to extract further information about the underlying distribution.

CHRISTOPH ORTNER, UBC
[Saturday December 2 / samedi 2 décembre, 16:30 – Soprano A]
Efficient Parameterization of Many-body Interaction

I will review the atomic cluster expansion (ACE), which provides a systematic, efficient, and interpretable parameterisation of many-body interaction in particle systems. It can be thought of as a method to enlarge the design space of equivariant neural network architectures. ACE is well-suited for parameterising surrogate models of particle systems where it is important to incorporate symmetries and geometric priors into models without sacrificing systematic improvability. The most successful application so far is "learning" interatomic potentials (or, force fields) but the applicability is much broader ; it has been adapted to other contexts such as electronic structure (parameterising Hamiltonians), quantum chemistry (wave functions), and elementary particle physics (e.g., jet tagging). The main purpose of my talk will be to explain the framework that enables this breadth of applications, and point out theoretical questions and challenges.

SERGE PRUDHOMME, Polytechnique Montréal
[Saturday December 2 / samedi 2 décembre, 16:00 – Soprano A]
Reduced-order modeling for the wave equation using Green's functions and neural networks

Several deep learning methods have been developed in recent years for the solution of PDE-based problems with the objective of producing techniques that are more flexible and possibly faster than classical discretization approaches. Deep operator networks (DeepONet), for example, aim at solving partial differential equations by learning the inverse of the differential operator for a wide class of input parameters. However, the approach turns out to be expensive for the wave equation at high frequency regimes as the identification of the network parameters may converge slowly. In this talk, we propose an approach based on the representation of the exact solution in terms of the Green's function. The resulting neural network architecture will be referred to as Green operator networks (GreenONets). The novel architecture yields a faster learning and a better generalization error when compared to the classical DeepONet architecture. Performance of the GreenONets and DeepONets will be compared on several numerical examples dealing with wave propagation in homogeneous and heterogeneous media.

ELINA ROBEVA, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 9:00 – Soprano A]
Learning Causal Models via Algebraic Constraints

Abstract: One of the main tasks of causal inference is to learn direct causal relationships among observed random variables. These relationships are usually depicted via a directed graph whose vertices are the variables of interest and whose edges represent direct causal effects. In this talk we will discuss the problem of learning such a directed graph for a linear causal model. We will specifically address the case where the graph may have directed cycles. In general, the causal graph cannot be learned uniquely from observational data. However, in the special case of linear non-Gaussian acyclic causal models, the directed graph can be found uniquely. When cycles are allowed the graph can be learned up to an equivalence class. We characterize the equivalence classes of such cyclic graphs and we propose algorithms for causal discovery. Our methods are based on using specific polynomial relationships which hold among the second and higher order moments of the random vector and which can help identify the graph.

Mathematics of Machine Learning
Les mathématiques de l'apprentissage automatique

LUANA RUIZ, Johns Hopkins University
[Saturday December 2 / samedi 2 décembre, 10:00 – Soprano A]
Machine Learning on Large-Scale Graphs

Graph neural networks (GNNs) are successful at learning representations from most types of network data but suffer from limitations in large graphs, which do not have the Euclidean structure that time and image signals have in the limit. Yet, large graphs can often be identified as being similar to each other in the sense that they share structural properties. Indeed, graphs can be grouped in families converging to a common graph limit – the graphon. A graphon is a bounded symmetric kernel which can be interpreted as both a random graph model and a limit object of a convergent sequence of graphs. Graphs sampled from a graphon almost surely share structural properties in the limit, which implies that graphons describe families of similar graphs. We can thus expect that processing data supported on graphs associated with the same graphon should yield similar results. In my research, I formalize this intuition by showing that the error made when transferring a GNN across two graphs in a graphon family is small when the graphs are sufficiently large. This enables large-scale graph machine learning by transference: training GNNs on moderate-scale graphs and executing them on large-scale graphs.

MATTHEW SCOTT, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 10:00 – Soprano A]
When are generative models suitable for signal recovery from subsampled Fourier measurements ?

Using the range of generative models as prior sets has shown promise for recovering signals from what appears to be an incomplete set of noisy linear measurements. We present sample complexity bounds when the measurements are subsampled from the rows of a fixed unitary matrix, e.g., subsampled Fourier measurements. To provide meaningful bounds, we introduce a parameter quantifying whether a generative model is well-conditioned with respect to subsampled unitary measurements. We further show how these sample complexity bounds depend on the sampling distribution, and how they can be improved by picking the sampling probabilities in a manner adapted to the generative model.

Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations

Org: Stephen Anco (Brock University), **Damir Kinzebulatov** (Université Laval) and/et **Alexey Shevyakov** (University of Saskatchewan)

The session will bring together researchers working on modern analytic methods for nonlinear partial differential equations (PDE) and stochastic differential equations (SDE), with the purpose of mutual enrichment of the areas through the exchange of expertise, methods, and applications, and fostering new collaborations. The session will include talks devoted to exact and approximate solutions, equation structure, relations between stochastic and deterministic continuum equations, and mathematical modeling with PDEs and SDEs.

Schedule/Horaire **Room/Salle: UQAM - PK-2605**

Saturday December 2 — samedi 2 décembre

8:00 - 8:30	Ryan Thiessen (Alberta), *Travelling Wave Solutions in a Novel Glioma Invasion Model.* (p. 150)
8:30 - 9:00	Alan Lindsay (Notre Dame), *Inferring the source of diffusive sources through extreme statistics.* (p. 148)
9:00 - 9:30	Raphael Madou (McGill), *Strong solutions on SDEs with singular (form-bounded) drifts via Rockner-Zhao approach.* (p. 148)
9:30 - 10:00	Greg Lewis (UOIT), *Numerical continuation for sheared annular electroconvection* (p. 148)
10:00 - 10:30	Theodore Kolokolnikov (Dalhousie), *Recurrent and chaotic outbreaks in SIR model* (p. 147)
15:00 - 15:30	Alex Chernyavsky (Buffalo), *Whitham modulation theory for the Zakharov-Kuznetsov equation and stability analysis of its periodic traveling wave solutions* (p. 147)
15:30 - 16:00	Danial Saadatmand (Brock) (p. 149)
16:00 - 16:30	Thomas Wolf (Brock), *Radial compressible fluid flow in $n > 1$ dimensions and their conserved integrals, invariants, symmetries and Casimirs* (p. 151)
16:30 - 17:00	Stephen Anco (Brock), *Exact solitary wave solutions for a coupled gKdV-NLS system* (p. 146)
17:00 - 17:30	Alexey Shevyakov (Saskatchewan), *New exact plasma equilibria with axial and helical symmetry* (p. 150)

Sunday December 3 — dimanche 3 décembre

8:00 - 8:30	Elkin Ramírez (McMaster), *SYSTEMATIC SEARCH FOR EXTREME BEHAVIOUR IN 3D NAVIER-STOKES EQUATIONS BASED ON THE LADYZHENSKAYA-PRODI-SERRIN CONDITIONS* (p. 149)
8:30 - 9:00	Wei Sun (Concordia), *Periodic solutions of some SDEs and SPDEs* (p. 150)
9:00 - 9:30	Yana Nec (Thompson Rivers), *Weak solutions to diffusion equation with piecewise constant diffusivity* (p. 149)
9:30 - 10:00	Adilbek Kairzhan (Toronto), *A Hamiltonian Dysthe equation for deep-water gravity waves with constant vorticity* (p. 147)
10:00 - 10:30	Xiaowen Zhou (Concordia), *Speed of explosion for continuous-state branching processes with nonlinear branching mechanism* (p. 151)
15:00 - 15:30	Reihaneh Vafadar (Laval), *Weak well-posedness of SDEs with divergence-free drifts* (p. 150)
15:30 - 16:00	Maria Ntekoume (Concordia), *Symplectic non-squeezing for integrable PDEs: the KdV equation on the line* (p. 149)

Abstracts/Résumés

Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations

STEPHEN ANCO, Brock University
[Saturday December 2 / samedi 2 décembre, 16:30 – UQAM - PK-2605]
Exact solitary wave solutions for a coupled gKdV-NLS system

We study a coupled gKdV-NLS system $u_t + \alpha u^p u_x + \beta u_{xxx} = \gamma(|\psi|^2)_x$ and $i\psi_t + \kappa\psi_{xx} = \sigma u\psi$ with a general nonlinearity power $p > 0$, which has been introduced in the literature to model energy transport in anharmonic crystal materials. There is a strong interest in obtaining exact solutions describing frequency-modulated solitary waves $u = U(x - ct)$, $\psi = e^{i\omega t}\Psi(x - ct)$, where c is the wave speed, and ω is the modulation frequency. For the KdV case $p = 1$, some solutions are known, while for the mKdV case $p = 2$, no exact solutions have been found to-date, and nothing has been done for higher nonlinearities $p \geq 3$.

In the present work, we derive exact solutions for $p = 1, 2, 3, 4$, starting from the travelling wave ODE system satisfied by U and Ψ. The method is new: (i) obtain first integrals by use of multi-reduction symmetry theory ; (ii) apply a hodograph transformation which leads to triangular (decoupled) system ; (iii) introduce an ansatz for polynomial solutions of the base ODE ; (iv) characterize conditions under which solutions yield solitary waves ; (v) solve an algebraic system for the coefficients in the ansatz under those conditions. The resulting solitary waves exhibit a wide range of features: bright and dark peaks ; single peaked and multi-peaked ; zero and non-zero backgrounds.

ALEX CHERNYAVSKY, State University of New York at Buffalo
[Saturday December 2 / samedi 2 décembre, 15:00 – UQAM - PK-2605]
Whitham modulation theory for the Zakharov-Kuznetsov equation and stability analysis of its periodic traveling wave solutions

We derive the Whitham modulation equations for the Zakharov-Kuznetsov equation via a multiple scales expansion and averaging two conservation laws over one oscillation period of its periodic traveling wave solutions. We then use the Whitham modulation equations to study the transverse stability of the periodic traveling wave solutions. We find that all periodic solutions traveling along the first spatial coordinate are linearly unstable with respect to purely transversal perturbations, and we obtain an explicit expression for the growth rate of perturbations in the long wave limit. We validate these predictions by linearizing the equation around its periodic solutions and solving the resulting eigenvalue problem numerically. We also calculate the growth rate of the solitary waves analytically. The predictions of Whitham modulation theory are in excellent agreement with both of these approaches.Finally, we generalize the stability analysis to periodic waves traveling in arbitrary directions and to perturbations that are not purely transversal, and we determine the resulting domains of stability and instability.

ADILBEK KAIRZHAN, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 9:30 – UQAM - PK-2605]
A Hamiltonian Dysthe equation for deep-water gravity waves with constant vorticity

In this talk I present a study of the water wave problem in a two-dimensional domain of infinite depth in the presence of nonzero constant vorticity. A goal is to describe the effects of uniform shear flow on the modulation of weakly nonlinear quasi-monochromatic surface gravity waves. Starting from the Hamiltonian formulation of this problem and using techniques from Hamiltonian transformation theory, we derive a Hamiltonian Dysthe equation for the time evolution of the wave envelope. Consistent with previous studies, we observe that the uniform shear flow tends to enhance or weaken the modulational instability of Stokes waves depending on its direction and strength. Our method also provides a non-perturbative procedure to reconstruct the surface elevation from the wave envelope, based on the Birkhoff normal form transformation to eliminate all non-resonant triads. This model is tested against direct numerical simulations of the full Euler equations and against a related Dysthe equation derived by Curtis, Carter and Kalisch (J. Fluid Mech., vol. 855, 2018, pp. 322–350) in the context of constant vorticity. Very good agreement is found for a range of values of the vorticity.

THEODORE KOLOKOLNIKOV, Dalhousie
[Saturday December 2 / samedi 2 décembre, 10:00 – UQAM - PK-2605]
Recurrent and chaotic outbreaks in SIR model

Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations

We examine several extensions to the basic SIR model, which are able to induce recurrent outbreaks (the basic SIR model by itself does not exhibit recurrent outbreaks). We first analyze how slow seasonal variations can destabilize the endemic equilibrium, leading to recurrent outbreaks. In the limit of slow immunity loss, we derive asymptotic thresholds that characterize this transition. In the outbreak regime, we use asymptotic matching to obtain a two-dimensional discrete map which describes outbreak times and strength. We then analyse the resulting map using linear stability and numerics. As the frequency of forcing is increased, the map exhibits a period-doubling route to chaos which alternates with periodic outbreaks of increasing frequency. Other extensions that can lead to recurrent outbreaks include addition of noise, state-dependent variation and fine-graining of model classes.

GREG LEWIS, Ontario Tech University
[Saturday December 2 / samedi 2 décembre, 9:30 – UQAM - PK-2605]
Numerical continuation for sheared annular electroconvection

We use numerical continuation methods to investigate the flows that occur in a mathematical model of the sheared annular electroconvection experiment. In particular, we study the flow of a liquid crystal film suspended between two annular electrodes, and subjected to an electric potential difference and a radial shear. Due to the Smectic A nature of the liquid crystal, the fluid can be considered two-dimensional, and its motion can be effectively modelled using the 2-D incompressible Navier-Stokes equations coupled with an equation for charge continuity. This system is a close analogue of some laboratory-scale geophysical flow experiments (e.g. the differentially-heated rotating annulus).

For small values of the applied electric potential, a steady axisymmetric flow is observed. As this parameter is increased, a transition to rotating waves, followed by a secondary transition to amplitude-modulated rotating waves, occurs. Subsequently, period-doubling and symmetry breaking bifurcations lead to more complicated flows. Further increase in the parameter leads to flows that resemble a rotating wave with one or two isolated vortices.

We investigate the bifurcation structure of solutions that connects these various types of flow using numerical continuation based on time-integration. In particular, a Newton-Krylov method, which exploits the rotating nature of the flows, is implemented for the continuation of rotating waves and modulated rotating waves, and linear stability analysis of a flow map is used to identify the flow transitions that result due to changes in the model parameters.

This is joint work with Mary Pugh and Stephen Morris (University of Toronto).

ALAN LINDSAY, University of Notre Dame
[Saturday December 2 / samedi 2 décembre, 8:30 – UQAM - PK-2605]
Inferring the source of diffusive sources through extreme statistics.

Title: Inferring the source of diffusive sources through extreme statistics.

Abstract: A common inverse problem is to recover the source of diffusing molecules from noisy arrivals to small reactive sites. In this talk I will present a perspective on this important problem via extreme statistics. The central premise is that when a single stochastic process exhibits large variability (unreliable), the extrema of multiple processes has a remarkably tight distribution (reliable). In this talk I will present some background on extreme statistics followed by specific applications to directional sensing - the process of acquiring the direction of diffusive sources. We find that extreme statistics provide new insights and corroborate real world observations.

RAPHAEL MADOU, McGill University
[Saturday December 2 / samedi 2 décembre, 9:00 – UQAM - PK-2605]
Strong solutions on SDEs with singular (form-bounded) drifts via Rockner-Zhao approach.

Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations

In this talk, we use the Rockner-Zhao approach to establish strong well-posedness result for SDEs featuring singular drift term, subject to certain minimal assumptions.

The talk is based on joint work with Damir Kinzebulatov.

YANA NEC, Thompson Rivers University

[Sunday December 3 / dimanche 3 décembre, 9:00 – UQAM - PK-2605]

Weak solutions to diffusion equation with piecewise constant diffusivity

A wide class of weak solutions to the steady inhomogeneous diffusion equation is constructed in three sets of coordinates: polar, spherical and elliptic. This framework is relevant in applications involving fluid flow in porous media, but is also very interesting mathematically. Their existence is shown to depend on the geometric layout of the domain, i.e. the particular division into sub-domains, as well as the diffusivity assigned to each sub-domain. The existence hinges on the null and column spaces of a set of matrices, intriguingly identical in all three systems of coordinates. A fixed point of a new type – half stable - half unstable node – is identified with the aid of this class of weak solutions. A variety of flow patterns associated with these solutions allows to explain certain modelling difficulties encountered in large scale environmental applications, such as aquifer sparging wells, natural and landfill gas wells, as well as petroleum and hydraulic wells. One of the prominent properties of these weak solutions is that with the relaxation of the constraint of axial symmetry – that is obviously unrealistic for the foregoing applications – the locus of zero normal flux comprises separatrices connecting isolated stagnation points. The area enclosed is shown to be realistic in stark contrast to the result obtained with an axially symmetric solution, where the locus comprises a curve of stagnation points. The new class of solutions augments known exact solutions to Laplaces's equation in settings where it is separable.

MARIA NTEKOUME, Concordia University

[Sunday December 3 / dimanche 3 décembre, 15:30 – UQAM - PK-2605]

Symplectic non-squeezing for integrable PDEs: the KdV equation on the line

Gromov's symplectic non-squeezing theorem asserts that a smooth symplectomorphism cannot map a ball wholly inside a thinner cylinder. In this talk we will review methods to obtain infinite-dimensional analogues of this theorem for Hamiltonian PDEs. In particular, we will prove that the KdV flow on the line cannot squeeze a ball in $\dot{H}^{-\frac{1}{2}}(\mathbb{R})$ into a cylinder of lesser radius. If time permits, further applications of this method to other completely integrable PDEs will be discussed.

ELKIN RAMÍREZ, McMaster University

[Sunday December 3 / dimanche 3 décembre, 8:00 – UQAM - PK-2605]

SYSTEMATIC SEARCH FOR EXTREME BEHAVIOUR IN 3D NAVIER-STOKES EQUATIONS BASED ON THE LADYZHENSKAYA-PRODI-SERRIN CONDITIONS

This investigation concerns a systematic search for potential singularities in 3D Navier-Stokes flows. It is based on the Ladyzhenskaya-Prodi-Serrin conditions, which assert that if the quantity $\int_0^T \|\mathbf{u}(t)\|^p_{L^q(\Omega)}\,dt$ remains bounded, given that $2/p + 3/q \leq 1$ and $q > 3$, then the solution $\mathbf{u}(t)$ of the Navier-Stokes system remains smooth within the interval $[0, T]$. Hence, should a singularity arise at any instant within the interval $[0, T]$, we would anticipate an unbounded growth of this quantity.

We examine these conditions by solving numerically a set of variational optimization problems. These problems aim to determine initial conditions $\mathbf{u}_0$ such tat the corresponding flow maximizes $\int_0^T \|\mathbf{u}(t)\|^p_{L^q(\Omega)}\,dt$ for different values of T while satisfying specific constraints. We address these problems computationally, employing a large-scale adjoint-based gradient approach in Sobolev and Lebesgue spaces.

We extend earlier work by considering various values of q, and different types of gradients to discretize gradient flows. We also studied the limiting case $q = 3$ where the regularity condition is slightly different.

Models, Methods, and Solutions: New Developments in Nonlinear Partial Differential Equations and Stochastic Differential Equations

---

DANIAL SAADATMAND, Brock
[Saturday December 2 / samedi 2 décembre, 15:30 – UQAM - PK-2605]

ALEXEY SHEVYAKOV, University of Saskatchewan
[Saturday December 2 / samedi 2 décembre, 17:00 – UQAM - PK-2605]
New exact plasma equilibria with axial and helical symmetry

Abstract: Exact closed-form solutions of magnetohydrodynamics equations, with and without dynamics, are derived under axial and helical symmetry assumptions. For each symmetry, two distinct families of solutions arise that correspond to different pressure profiles. One profile models plasmas supported by external pressure, and is suitable for the description of plasma configurations in a medium such as atmosphere. The second profile features higher pressure inside the plasma domain and models plasmas residing in a vacuum. Examples of solutions bounded and unbounded in the radial direction, including solutions with boundary current sheets, are presented and discussed. This work is joint with Jason Keller.

WEI SUN, Concordia University
[Sunday December 3 / dimanche 3 décembre, 8:30 – UQAM - PK-2605]
Periodic solutions of some SDEs and SPDEs

We investigate periodic solutions of stochastic dynamical systems induced by some SDEs and SPDEs. We start with different definitions of periodic solutions. Then, we explain how to use the strong Feller property and irreducibility of time-inhomogeneous semigroups to study uniqueness of periodic solutions. Concrete examples are presented to illustrate the results. This talk is based on joint papers with Zuo-Huan Zheng, Xiao-Xia Guo and Chun Ho Lau.

RYAN THIESSEN, University of Alberta
[Saturday December 2 / samedi 2 décembre, 8:00 – UQAM - PK-2605]
Travelling Wave Solutions in a Novel Glioma Invasion Model.

In a recent paper, Osswald and collaborators presented a detailed study of in-vivo glioma invasion patterns in the healthy brain tissue of living mice. This paper showed that specialized cancer cells build a network much like a healthy brain neuronal network. Working jointly with Thomas Hillen, Kevin Painter, and Nadia Loy, we aim to incorporate this discovery of network formation into previous Glioma blastoma models. Our model is based on the kinetic model framework, where we can quickly introduce new reaction dynamics for the network formation. We can arrive at coupled non-cooperative reaction-diffusion equations by making quasi-equilibrium assumptions and taking the diffusion limit. From this system, we will show the existence of Traveling waves with a minimal spreading speed.

OLGA TRICHTCHENKO, Western
[UQAM - PK-2605]

REIHANEH VAFADAR, Laval university
[Sunday December 3 / dimanche 3 décembre, 15:00 – UQAM - PK-2605]
Weak well-posedness of SDEs with divergence-free drifts

We discuss results on weak well-posedness of SDEs with time-inhomogeneous divergence-free singular drifts. These drifts belong to a large class of (form bounded-type) drifts containing e.g. the largest possible Morrey class, which brings us close to the minimal assumptions on the drift such that the corresponding parabolic equation still admits a regularity theory. Our proofs

use De Giorgi-Moser's method supplemented with a new iteration procedure, earlier results proved using Nash's method. This is a joint work in progress with D. Kinzebulatov.

THOMAS WOLF, Brock University

[Saturday December 2 / samedi 2 décembre, 16:00 – UQAM - PK-2605]

Radial compressible fluid flow in $n > 1$ dimensions and their conserved integrals, invariants, symmetries and Casimirs

In this joint work with Stephen Anco conserved integrals and invariants (advected scalars) are studied for the equations of radial compressible fluid flow in $n > 1$ dimensions. Three invariants of up to first order had been found apart from the known entropy.

A recursion operator on invariants is presented, producing two hierarchies of higher-order invariants. One of them consist of Hamiltonian Casimirs. The other one holding non-Casimirs holds only for an entropic equation of state (EOS).

The Hamiltonian structure of the radial fluid flow equations in combination with these non-Casimir invariants provides a corresponding hierarchy of generalized symmetries. The Lie algebra of the first-order symmetries is non-abelian.

For the special cases of barotropic EOS and entropic EOS two new kinematic conserved integrals yield additional first-order generalized symmetries. These provide an explicit transformation group acting on solutions of the fluid equations.

XIAOWEN ZHOU, Concordia University

[Sunday December 3 / dimanche 3 décembre, 10:00 – UQAM - PK-2605]

Speed of explosion for continuous-state branching processes with nonlinear branching mechanism

Continuous-state branching process (CSBP) with nonlinear branching mechanism is the unique nonnegative solution to certain stochastic differential equation driven by Brownian motion and (or) Poisson random measure. It can also be obtained from spectrally positive Lévy processes by a generalized Lamperti transform. These generalized CSBPs allow rich asymptotic behaviors such as extinction, explosion and coming down from infinity. The explosion behaviors for nonlinear CSBPs have been studied by Li and Zhou (2021) when the big jumps of the process have a finite first moment. In this talk we further consider the explosion behaviors for processes with jumps of infinite first moment. In particular, we identify the speed of explosion when the associated Laplace exponent and the rate function are both regularly varying. This talk is based on joint work with Clement Foucart and Bo Li.

Number Theory by early career researchers

Org: Payman Eskandari (University of Winnipeg) and/et **Samprit Ghosh** (University of Calgary)

This session aims to give a platform to graduating PhD students, recently graduated PhD holders and postdocs to showcase their research in the field of Number Theory. We hope that this will be a great opportunity to exchange ideas, network and gain exposure. We plan to consider all contributions in algebraic and analytic number theory, as well as arithmetic geometry.

Schedule/Horaire **Room/Salle: Grand Salon Opera B**

Saturday December 2 samedi 2 décembre

8:00 - 8:30	Erman Isik (University of Ottawa), *Modular approach to Diophantine equation $x^p + y^p = z^3$ over some number fields* (p. 155)
8:30 - 9:00	Jonathan Love (McGill University), *On isospectral quaternion orders* (p. 156)
9:00 - 9:30	Kübra Benli (University of Lethbridge), *Discrete moments of the derivatives of the Riemann zeta function* (p. 153)
9:30 - 10:00	Ertan Elma (University of Lethbridge), *Number of Prime Factors with a Given Multiplicity* (p. 154)
10:00 - 10:30	Mihir Deo (University of Ottawa), *Signed p-adic L-functions of Bianchi modular forms* (p. 153)
15:00 - 15:30	Sedanur Albayrak (University of Calgary), *Quantitative estimates for the size of an intersection of sparse automatic sets* (p. 153)
15:30 - 16:00	Gregory Knapp (University of Calgary), *Polynomial Root Separation and Mahler Measure* (p. 155)
16:00 - 16:30	Samprit Ghosh (University of Calgary), *Minimal Subfields of Elliptic curves* (p. 154)
16:30 - 17:00	Félix Baril.Boudreau (University of Lethbridge), *Value-Distribution of Logarithmic Derivatives of Real Quadratic Dirichlet L-functions over the Projective Line* (p. 153)
17:00 - 17:30	Subham Roy (Université de Montréal), *Areal Mahler measure of multivariable polynomials* (p. 157)
17:30 - 18:00	Isabella Negrini (University of Toronto), *A Shintani map for rigid cocycles* (p. 156)

Sunday December 3 dimanche 3 décembre

8:00 - 8:30	Xiao Zhong (University of Waterloo), *Preimages Question for Surjective Endomorphisms on $(\mathbb{P}^1)^n$* (p. 157)
8:30 - 9:00	David Nguyen (Queens University), *Shifted convolutions and applications* (p. 156)
9:00 - 9:30	Soheil Memariansorkhabi (University of Toronto), *Growth Rate of Rational Points on Non-Compact Complex Ball Quotients* (p. 156)
9:30 - 10:00	Mishty Ray (University of Calgary), *Introduction to geometry of local Arthur packets* (p. 157)
10:00 - 10:30	Chi Hoi (Kyle) Yip (Kyle) Yip (University of British Columbia), *Additive decompositions of multiplicative subgroups* (p. 157)
15:00 - 15:30	Mathilde Gerbelli-Gauthier (McGill University), *An average Sato-Tate for non-tempered representations.* (p. 154)
15:30 - 16:00	Erik Holmes (University of Toronto), *Shapes and asymptotics in number theory* (p. 155)
16:00 - 16:30	Marti Roset Julià (McGill University), *The Gross–Kohnen–Zagier theorem via p-adic uniformization* (p. 155)
16:30 - 17:00	Mohammadreza Mohajer (University of Ottawa), *P-adic periods and p-adic subgroup theorem for 1-motives* (p. 156)
17:00 - 17:30	Abhishek Bharadwaj (Queen's University), *On primitivity and vanishing of Dirichlet series* (p. 153)
17:30 - 18:00	Oussama Hamza (University of Western Ontario), *On extensions of number fields with given quadratic algebras and cohomology* (p. 154)

Abstracts/Résumés

Number Theory by early career researchers

SEDANUR ALBAYRAK, University of Calgary
[Saturday December 2 / samedi 2 décembre, 15:00 – Grand Salon Opera B]
Quantitative estimates for the size of an intersection of sparse automatic sets

In this talk, I will talk about use of automata theory in answering problems in number theory. In 1844, Catalan conjectured that the set consisting of natural numbers of the form $2^n + 1$, $n \geq 0$ and the set consisting of powers of 3 has finite intersection. In fact, we can answer such question in more generality, that is, instead of 2 and 3, we can show this for k and ℓ that are multiplicatively independent (meaning if $k^a = \ell^b$, then $a = b = 0$). In automata-theoretic terms, these sets described above are sparse 2-automatic and sparse 3-automatic sets, respectively. In fact, a sparse k-automatic set can be more complicated than having elements that are of the form k^n or $k^n + 1$, and hence, we are answering a more general question. Moreover, we also prove our result in a multidimensional setting in line with the existing results in the theory of formal languages and finite automata. We show that the intersection of a sparse k-automatic subset of $\mathbb{N}^d$ and a sparse ℓ-automatic subset of $\mathbb{N}^d$ is finite and we give effectively computable upper bounds on the size of the intersection in terms of data from the automata that accept these sets.

FÉLIX BARIL.BOUDREAU, University of Lethbridge
[Saturday December 2 / samedi 2 décembre, 16:30 – Grand Salon Opera B]
Value-Distribution of Logarithmic Derivatives of Real Quadratic Dirichlet L-functions over the Projective Line

Let $\mathbb{F}_q(t)$ be a rational function field over a finite field $\mathbb{F}_q$. To each monic irreducible polynomial D in $\mathbb{F}_q[t]$, we can attach a Kronecker symbol χ_D and this is a real quadratic Dirichlet character. We can then define the associated Dirichlet L-function $L(s, \chi_D)$ as some infinite Euler product which, thanks to the work of André Weil, is a polynomial with integer coefficients in the variable $T = q^{-s}$. In her 2019 thesis, Allysa Lumley studied distributions of values of these L-functions for $\mathrm{Re}(s) > \frac{1}{2}$, uncovering that they coincide with some probabilistic random models. Inspired by the seminal work of Yasutaka Ihara on Euler-Kronecker constants of global fields, we study analogous distributions for their logarithmic derivatives $L'(s, \chi_D)/L(s, \chi_D)$. We currently prove that the distribution of these quotients at $s = 1$ is well-approximated by some random model. Moreover, we show that this random model has exponential decay, implying that the distribution function associated with our random model admits a smooth density function. This is ongoing joint work with Amir Akbary (University of Lethbridge).

KÜBRA BENLI, University of Lethbridge
[Saturday December 2 / samedi 2 décembre, 9:00 – Grand Salon Opera B]
Discrete moments of the derivatives of the Riemann zeta function

In this talk, we will discuss an estimate for a discrete mean value of the Riemann zeta function and its derivatives multiplied by Dirichlet polynomials. Assuming the Riemann Hypothesis, we derive a lower bound for the $2k^{\text{th}}$ discrete moment of the derivatives of the Riemann zeta function evaluated at its nontrivial zeros. This talk is based on a joint work with Ertan Elma and Nathan Ng.

ABHISHEK BHARADWAJ, Queen's University
[Sunday December 3 / dimanche 3 décembre, 17:00 – Grand Salon Opera B]
On primitivity and vanishing of Dirichlet series

For a rational valued periodic function, we associate a Dirichlet series and provide a new necessary and sufficient condition for the vanishing of this Dirichlet series specialized at positive integers. This question was initiated by Chowla, and carried out by Okada for a particular infinite sum. Our approach relies on the decomposition of the Dirichlet characters in terms of primitive characters. Using our approach, we find some new family of natural numbers for which a conjecture of Erdős holds and provide some other applications.

Number Theory by early career researchers

MIHIR DEO, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 10:00 – Grand Salon Opera B]
Signed p-adic L-functions of Bianchi modular forms

Let $p \geq 3$ be a prime number. Let K be an imaginary quadratic field in which p splits. Let $\mathcal{F}$ be a cuspidal Bianchi eigenform of weight (k, k) over K, where $k \geq 2$ is an integer. In this talk, we will discuss two scenarios of the decomposition of unbounded p-adic L-functions into a linear combination of signed p-adic L-functions in the spirit of Lei-Loeffler-Zerbes, Pollack, and Sprung.

The first half of the talk is about decomposing the two-variable p-adic L-functions $L_p(\mathcal{F})$ constructed by Williams for small slope cuspidal Bianchi eigenforms $\mathcal{F}$, which are non-ordinary at both the primes above p.

In the other half, we discuss a work in progress on p-adic Asai L-functions of Bianchi modular forms. We generalize the construction of Loeffler-Williams in the ordinary case to the non-ordinary case, giving rise to unbounded distributions, which we decompose into bounded measures.

ERTAN ELMA, University of Lethbridge
[Saturday December 2 / samedi 2 décembre, 9:30 – Grand Salon Opera B]
Number of Prime Factors with a Given Multiplicity

For natural numbers $k, n \geqslant 1$, let $\omega_k(n)$ be the number of prime factors of n with multiplicity k. The functions $\omega_k(n)$ with $k \geqslant 1$ are refined versions of the well-known function $\omega(n)$ counting the number of distinct prime factors of n without any conditions on the multiplicities.

In this talk, we will cover several elementary, analytic and probabilistic results about the functions $\omega_k(n)$ with $k \geqslant 1$ and their function field analogues in polynomial rings with coefficients from a finite field. In particular, we will see that the function $\omega_1(n)$ and its function field analogue satisfy the Erdős-Kac Theorem. The results we will see in this talk are based on joint works with Yu-Ru Liu, with Sourabhashis Das, Wentang Kuo and Yu-Ru Liu, and with Greg Martin.

MATHILDE GERBELLI-GAUTHIER, McGill University
[Sunday December 3 / dimanche 3 décembre, 15:00 – Grand Salon Opera B]
An average Sato-Tate for non-tempered representations.

The (now proved) Sato-Tate conjecture predicts the distribution of Hecke eigenvalues of certain non-CM modular forms. After introducing a representation-theoretic reformulation and generalizations to groups beyond GL_2, I'll discuss joint results with Rahul Dalal giving a Sato-Tate result on average for certain non-tempered representations on unitary groups.

SAMPRIT GHOSH, University of Calgary
[Saturday December 2 / samedi 2 décembre, 16:00 – Grand Salon Opera B]
Minimal Subfields of Elliptic curves

Let E be an elliptic curve defined over a number field K and let L/K be a finite Galois extension with Galois group $G = Gal(L/K)$. Akbary and Murty introduced the idea of a minimal subfield : $K \subseteq M \subseteq L$, minimal, such that $rank\ E(M) = rank\ E(L)$. They gave a description of the possibilities for $Gal(M/K)$ when the rank $E(L)$ is small. In this talk, we'll present results extending this idea and investigate the possibilities for $Gal(M/K)$ when the $rank\ E(L)$ increases from that of $E(K)$ by a small amount. If time permits we'll also venture in the analytic side of things and present some results in connection to the BSD conjecture.

Number Theory by early career researchers

OUSSAMA HAMZA, Western University
[Sunday December 3 / dimanche 3 décembre, 17:30 – Grand Salon Opera B]
On extensions of number fields with given quadratic algebras and cohomology

At the beginning of the century, Labute and Minac introduced a criterion, on presentations of pro-p groups, ensuring that the cohomological dimension is two. Groups with presentations satisfying this condition are called mild.

In this talk, we introduce a new criterion on the presentation of finitely presented pro-p groups which allows us to compute their cohomology groups and infer quotients of mild groups of cohomological dimension strictly larger than two.

We interpret these groups as Galois groups over p-rational fields with prescribed ramification and splitting.

ERIK HOLMES, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 15:30 – Grand Salon Opera B]
Shapes and asymptotics in number theory

In this talk we investigate a possible connection between the distribution of shapes of number fields and Malle's conjecture. Specifically we will discuss joint work with Rob Harron in which we study the shape of non-Galois sextic fields: i.e. the family of sextic fields which have Galois group $C_3 \wr C_2$ and which were the first counter example to Malle's conjecture. We describe our distribution results within this family and show how they relate to the asymptotics of these fields.

ERMAN ISIK, University of Ottawa
[Saturday December 2 / samedi 2 décembre, 8:00 – Grand Salon Opera B]
Modular approach to Diophantine equation $x^p + y^p = z^3$ over some number fields

Solving Diophantine equations, in particular, Fermat-type equations is one of the oldest and most widely studied topics in mathematics. After Wiles' proof of Fermat's Last Theorem using his celebrated modularity theorem, several mathematicians have attempted to extend this approach to various Diophantine equations and number fields over several number fields.

The method used in the proof of this theorem is now called the "modular approach", which makes use of the relation between modular forms and elliptic curves. I will first briefly mention the main steps of the modular approach, and then report our asymptotic result (joint work Ozman and Kara) on the solutions of the Fermat-type equation $x^p+y^p = z^3$ over various number fields.

MARTI ROSET JULIÀ, McGill University
[Sunday December 3 / dimanche 3 décembre, 16:00 – Grand Salon Opera B]
The Gross–Kohnen–Zagier theorem via p-adic uniformization

Let S be a set of rational places of odd cardinality containing infinity and a rational prime p. We can associate to S a Shimura curve X defined over $\mathbb{Q}$. The Gross–Kohnen–Zagier theorem states that certain generating series of Heegner points of X are modular forms of weight $3/2$ valued in the Jacobian of X. We will state this theorem and outline a new approach to prove it using the theory of p-adic uniformization and p-adic families of modular forms of half-integral weight. This is joint work in progress with Lea Beneish, Henri Darmon and Lennart Gehrmann.

GREGORY KNAPP, University of Calgary
[Saturday December 2 / samedi 2 décembre, 15:30 – Grand Salon Opera B]
Polynomial Root Separation and Mahler Measure

In 1964, Mahler proved a valuable lower bound on the separation of a polynomial—the minimal distance between distinct roots of that polynomial—in terms of the Mahler measure of that same polynomial. Many authors, including Bugeaud, Dujella, Fang,

Koiran, Pejkovic, Rump, and Salvy have improved, generalized, or investigated the sharpness of this lower bound. However, little attention has been paid to upper bounds on separation in terms of Mahler measure. In this talk, we examine some data on the distribution of separation against Mahler measure, we make a conjecture about an upper bound on separation in terms of Mahler measure, and we describe our partial results which prove that conjecture in certain cases.

JONATHAN LOVE, McGill University
[Saturday December 2 / samedi 2 décembre, 8:30 – Grand Salon Opera B]
On isospectral quaternion orders

Schiemann proved in 1997 that a 3-dimensional integral lattice is determined up to isometry by the number of elements of each norm. However, in all higher dimensions, there exist many pairs of non-isometric lattices that are isospectral, meaning they have the same number of elements of norm n for all integers n (equivalently, they have the same theta function). Given a quaternion algebra B_p over $\mathbb{Q}$ ramified at a single finite prime p, we show that if two maximal orders of B_p are isospectral, then they are isomorphic. This is joint work with Eyal Goren.

SOHEIL MEMARIANSORKHABI, University of Toronto
[Sunday December 3 / dimanche 3 décembre, 9:00 – Grand Salon Opera B]
Growth Rate of Rational Points on Non-Compact Complex Ball Quotients

Let X be a complex ball quotient by a nonuniform neat lattice in $PU(n,1)$. Using hyperbolic geometry, we provide a uniform lower bound on the volume of subvarieties of X in terms of a geometric quantity of X called systole. This has an arithmetic consequence: Suppose that the toroidal compactification of X is defined over a number field K. Then, with a mild assumption on X, the systole of X controls the growth rate of K-rational points on X.

MOHAMMADREZA MOHAJER, University of Ottawa
[Sunday December 3 / dimanche 3 décembre, 16:30 – Grand Salon Opera B]
P-adic periods and p-adic subgroup theorem for 1-motives

We define a countable space of p-adic periods of 1-motives with good reduction using the crystalline-de Rham comparison isomorphism and we state a p-adic period conjecture that is analogous to the classical periods. To define these periods, we need to find a "suitable" Betti-like $\bar{\mathbb{Q}}$-structure inside the crystalline realisation. We show that these periods come from p-adic integration theory that we developed for 1-motives with good reduction from the classical Fontaine-Messing p-adic integration theory. Also, we prove the p-adic subgroup theorem for 1-motive that similar to classical periods it implies that the p-adic period conjecture holds for 1-motives with good reduction.

ISABELLA NEGRINI, University of Toronto
[Saturday December 2 / samedi 2 décembre, 17:30 – Grand Salon Opera B]
A Shintani map for rigid cocycles

Rigid cocycles were defined in 2017 by Darmon and Vonk and give a promising framework to extend the theory of complex multiplication to real quadratic fields. They share striking parallels with modular forms, and their generalizations are the main ingredient in the emerging p-adic Kudla program. In previous work I showed how to build a map from half-integral weight modular forms to rigid cocycles in the style of the Shimura lift. In this talk I will show how to construct a map going in the opposite direction, in the style of the Shintani lift.

DAVID NGUYEN, Queen's University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Grand Salon Opera B]
Shifted convolutions and applications

Number Theory by early career researchers

Many problems in analytic number theory can be reduced to studying a suitable average of the shifted convolution $a(n)a(n+h)$, where $a(n)$ is the coefficients of interest. Determining which average is sufficient is part of the challenge. In this talk, I will survey my works on the shifted convolution problem when the coefficients $a(n)$ is the 3-fold divisor function and discuss an application.

MISHTY RAY, University of Calgary
[Sunday December 3 / dimanche 3 décembre, 9:30 – Grand Salon Opera B]
Introduction to geometry of local Arthur packets

Arthur packets help describe constituents of square integrable automorphic representations. When Arthur initially established his work, the local meaning was of interest. Adams, Barbasch, and Vogan proposed a geometric characterization of local Arthur packets for real groups, and Vogan's subsequent work established this perspective for p-adic groups. In this talk, we will see this geometric perspective in the language of Cunningham et.al. We will report on current progress and future directions of research in this area.

SUBHAM ROY, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 17:00 – Grand Salon Opera B]
Areal Mahler measure of multivariable polynomials

The (logarithmic) Mahler measure of a non-zero rational polynomial P in n variables is defined as the mean of $\log|P|$ (with respect to the normalized arclength measure) restricted to the standard n-torus ($\mathbb{T}^n = \{(x_1, \ldots, x_n) \in (\mathbb{C}^*)^n : |x_i| = 1, \forall\ 1 \leq i \leq n\}$). It has been related to special values of L-functions. Pritsker (2008) defined a natural counterpart of the Mahler measure, which is obtained by replacing the normalized arclength measure on the standard n-torus by the normalized area measure on the product of n open unit disks. It inherits many nice properties, such as the multiplicative ones. In this talk, we will investigate some similarities and differences between the two. We will also discuss some evaluations of the areal Mahler measure of multivariable polynomials, which also yields special values of L-functions. This is a joint work with Prof. Matilde Lalìn. If time permits we will also define and explore the Zeta Areal Mahler measure.

CHI HOI (KYLE) YIP, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 10:00 – Grand Salon Opera B]
Additive decompositions of multiplicative subgroups

A celebrated conjecture of Sárközy asserts that if p is a sufficiently large prime, then the set of non-zero squares in $\mathbb{F}_p$ has no non-trivial additive decomposition, that is, it cannot be written as $A + B = \{a + b : a \in A, b \in B\}$, where $A, B \subset \mathbb{F}_p$ and $|A|, |B| \geq 2$. The conjecture is widely open. In this talk, I will focus on the restricted sumset analog of Sárközy's conjecture. More precisely, we show that if $q > 13$ is an odd prime power, then the set of nonzero squares in $\mathbb{F}_q$ cannot be written as a restricted sumset $A\hat{+}A$. More generally, I will discuss related results for multiplicative subgroups over finite fields.

XIAO ZHONG, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 8:00 – Grand Salon Opera B]
Preimages Question for Surjective Endomorphisms on $(\mathbb{P}^1)^n$

Let K be a number field and let $f : (\mathbb{P}^1)^n \to (\mathbb{P}^1)^n$ be a dominant endomorphism defined over K. We show that if V is an f-invariant subvariety (that is, $f(V) = V$) then there is a positive integer s_0 such that $(f^{-s-1}(V) \setminus f^{-s}(V))(K) = \emptyset$ for every integer $s \geq s_0$, answering the Preimages Question of Matsuzawa, Meng, Shibata, and Zhang in the case of $(\mathbb{P}^1)^n$.

Recent Progress in Statistical Mechanics

Org: **Vojkan Jakšić** (McGill) and/et **Renaud Raquépas** (New York University)

This goal of this session is to invite North-American experts in mathematical physics, both classical and quantum, to share recent results, works in progress and open problems on fundamental questions in the field, with an emphasis on out-of-equilibrium phenomena.

Schedule/Horaire — Room/Salle: Symphonie 3B

Saturday December 2 — samedi 2 décembre

8:30 - 9:00	Benjamin Landon (University of Toronto), *Tail estimates for stationary KPZ models* (p. 159)
9:00 - 9:30	Nicholas Barnfield (McGill University), *On the Ziv-Merhav theorem beyond Markovianity* (p. 158)
9:30 - 10:00	Raphaël Grondin (McGill University), *A different approach to the Ziv-Merhav Theorem* (p. 159)
10:00 - 10:30	Gilles Parez (Université de Montréal), *The range of entanglement* (p. 159)
15:00 - 15:30	Alexander Fribergh (Université de Montréal), *Biased random walks on supercritical percolation clusters* (p. 159)
15:30 - 16:00	Elias Hess-Childs (New York University), *Propagation of chaos from the perspective of perturbation theory* (p. 159)
16:00 - 16:30	Lia Bronsard (McMaster University), *Boundary defects in liquid crystals/ Défauts aux limites dans les cristaux liquides* (p. 158)
16:30 - 17:00	Israel Michael Sigal (University of Toronto), *Some Rigorous Results on Propagation of Quantum Information* (p. 160)
17:00 - 17:30	Luc Vinet (Université de Montréal), *Entanglement of free fermiom systems, signal processing and algebraic combinatorics* (p. 160)
17:30 - 18:00	Jacob Shapiro (Princeton University), *Classification of disordered insulators in 1D* (p. 160)

Abstracts/Résumés

NICHOLAS BARNFIELD, McGill University
[Saturday December 2 / samedi 2 décembre, 9:00 – Symphonie 3B]
On the Ziv-Merhav theorem beyond Markovianity

In 1993, Ziv and Merhav proposed a "new notion of empirical informational divergence", or relative-entropy estimator which has met great practical application, yet has seen no significant development in the mathematical literature until recently. In this talk, I will compare their algorithm with more conventional universal entropic estimators and discuss a recent generalization of the Ziv-Merhav Theorem. This extension encompasses a broader class of decoupled measures including the the class of multi-level Markov measures covered by the original result as well as suitably regular g-measures amongst other examples.

Joint work with R. Grondin, G. Pozzoli, and R. Raquépas.

LIA BRONSARD, McMaster University
[Saturday December 2 / samedi 2 décembre, 16:00 – Symphonie 3B]
Boundary defects in liquid crystals/ Défauts aux limites dans les cristaux liquides

We study the effect of "weak" and "strong" boundary conditions on the location and type of defects observed in a Landau de Gennes thin-film model for liquid crystals. We study both the minimizers of the associated Ginzburg-Landau energy as well as the Gamma limit when the correlation length tends to zero. These represent joint works with S. Alama and L. van Brussel, as well as with A. Colinet.

Recent Progress in Statistical Mechanics

Nous étudions l'effet des conditions aux limites "faibles" et "fortes" sur l'emplacement et le type de défauts observés dans un modèle film mince de Landau de Gennes pour les cristaux liquides. Nous étudions à la fois les minimiseurs de l'énergie de Ginzburg-Landau associée ainsi que la limite Gamma lorsque la longueur de corrélation tend vers zéro. Il s'agit de travaux conjoints avec S. Alama et L. van Brussel, ainsi qu'avec A. Colinet.

ALEXANDER FRIBERGH, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 15:00 – Symphonie 3B]
Biased random walks on supercritical percolation clusters

We will study the existence, and non-existence, of scaling limits for the biased random walks on the supercritical percolation cluster in the zero-speed regime. This is joint work with Alan Hammond.

RAPHAËL GRONDIN, McGill University
[Saturday December 2 / samedi 2 décembre, 9:30 – Symphonie 3B]
A different approach to the Ziv-Merhav Theorem

This talk will present an almost-sure convergence result for a slight modification of the Ziv-Merhav cross-entropy estimator introduced in Nicholas's talk. This result encompasses examples which were not covered by our latest work such as hidden-Markov measures and unraveling of repeated quantum measurements, satisfying some mild decay assumptions. Our approach is based on the study of a rescaled cumulant-generating function called the cross-entropic pressure, which makes an analogy with the study of large deviations in statistical mechanics.

ELIAS HESS-CHILDS, New York University
[Saturday December 2 / samedi 2 décembre, 15:30 – Symphonie 3B]
Propagation of chaos from the perspective of perturbation theory

In this talk, I present my recent work on the mean-field behaviour of diffusions in the torus with bounded pairwise interaction. Using a perturbative expansion of the probability density marginals and iterating inequalities derived from the BBGKY hierarchy, I give sharp higher-order corrections to propagation of chaos. Joint work with Keefer Rowan.

BENJAMIN LANDON, University of Toronto
[Saturday December 2 / samedi 2 décembre, 8:30 – Symphonie 3B]
Tail estimates for stationary KPZ models

The limiting distributions of observables in the KPZ universality class exhibit tail exponents of $\frac{3}{2}$ and 3. In this talk we will review recent work studying the upper tail exponent $\frac{3}{2}$ in the moderate deviations regime of several KPZ models at finite size, including the stochastic six vertex model, the ASEP and a class of non-integrable interacting diffusions.

Joint work with C. Noack and P. Sosoe

GILLES PAREZ, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 10:00 – Symphonie 3B]
The range of entanglement

The investigation of entanglement in quantum many-body systems is a prominent research area, at the intersection of condensed matter, statistical mechanics and quantum information. In particular, quantifying entanglement in quantum critical systems provides us with strong insights regarding universal features of the phase transition. Due to the power-law decay of correlations at quantum critical points, it is generally believed that these systems exhibit long-range entanglement between separated

regions. In this talk, I will challenge this basic idea by showing that the long-distance entanglement depends greatly on the bosonic or fermionic nature of the model: bosonic theories lack such entanglement, while theories with fermions are substantially more entangled. I will also discuss the generalization of these results to the important case of multipartite systems.

Joint work with W. Witczak-Krempa (Université de Montréal), based on arXiv:2310.15273.

JACOB SHAPIRO, Princeton University
[Saturday December 2 / samedi 2 décembre, 17:30 – Symphonie 3B]
Classification of disordered insulators in 1D

In this talk I will describe some of the mathematical aspects of disordered topological insulators. These are novel materials which insulate in their bulk but (may) conduct along their edge ; the quintessential example is that of the integer quantum Hall effect. What characterizes these materials is the existence of a topological index, experimentally measurable and macroscopically quantized. Mathematically this is explained by applying algebraic topology to the space of appropriate quantum mechanical Hamiltonians ; I will survey some recent results mainly concentrating on the classification problem in one dimension, where the problem reduces to studying spaces of unitaries (resp. orthogonal projections) which essentially-commute with a fixed projection.

ISRAEL MICHAEL SIGAL, University of Toronto
[Saturday December 2 / samedi 2 décembre, 16:30 – Symphonie 3B]
Some Rigorous Results on Propagation of Quantum Information

In this talk I present some recent results on evolution of quantum correlations and states, and on quantum messaging in general many-body quantum lattice systems. The proofs are derived from a new type of the Lieb-Robinson bound. The talk based on a joint work with Jérémy Faupin, Marius Lemm and Jingxuan Zhang.

LUC VINET, IVADO/CRM, Université de Montréal
[Saturday December 2 / samedi 2 décembre, 17:00 – Symphonie 3B]
Entanglement of free fermiom systems, signal processing and algebraic combinatorics

Recent advances in the study of the entanglement entropy of free fermions will be presented and their connection with elements of signal processing and algebraic combinatorics will be stressed.

Work done in collaboration with Pierre-Antoine Bernard, Nicolas Crampé, Rafael Nepomechie, Gilles Parez et al.

Stochastic Control Theory and Applications
Théorie du contrôle stochastique et ses applications

Org: Ali D. Kara (University of Michigan), **Somnath Pradhan** (Queen's University) and/et **Serdar Yuksel** (Queen's University)

Stochastic control theory studies the control and optimization of dynamical systems under stochastic uncertainty. The uncertainty can be a part of the observation process and-or the evolution of the system itself. The processes are studied in continuous and discrete space/time settings. The theory may involve systems with a single agent under various information patterns, or decentralized systems with multiple agents under a variety of dynamical system models and information structures. The study of such controlled stochastic processes has grown around a very diverse mathematical theory building on optimal control, probability theory, PDE theory, dynamical systems, stochastic analysis, reinforcement learning etc. and has applications in engineering, computer science, statistics, finance, and operations research, among other areas. Stochastic control is a broad and highly active research area with various open problems and it brings different communities together. Hence, we aim to draw attention to recent progress in the field by organizing this session.

Schedule/Horaire **Room/Salle: UQAM - PK-1320**

Saturday December 2 samedi 2 décembre

8:00 - 8:30	Somnath Pradhan (Queen's University), *Existence and Discrete-Time Approximations of Optimal Controls for Controlled Diffusions under General Information Structures* (p. 164)
8:30 - 9:00	Minyi Huang (Carleton University), *Mean field social optimization: person-by-person optimality and master equations* (p. 164)
9:00 - 9:30	Asaf Cohen (University of Michigan), *Deep Neural Networks Methods for Mean Field Game Master Equation* (p. 163)
9:30 - 10:00	Peter Caines (McGill University), *Mean Field Games on Large Sparse and Dense Networks* (p. 162)
10:00 - 10:30	Joe Jackson (University of Chicago), *Sharp convergence rates for mean field control on the region of strong regularity* (p. 164)
15:00 - 15:30	Sina Sanjari (University of Illinois / Royal Military College), *Large Stochastic Exchangeable Teams, Their Mean-Field Limits, and Optimality of Symmetric Policies* (p. 165)
15:30 - 16:00	Johannes Wiesel (Carnegie Mellon University), *Martingale Schrödinger bridges* (p. 166)
16:00 - 16:30	Zachary Selk (Queen's University), *Robustness for Near-Brownian Noise via Rough Paths Theory* (p. 165)
16:30 - 17:00	Margaret Chapman (University of Toronto), *Risk-Aware Control Theory* (p. 162)
17:00 - 17:30	Dena Firoozi (University of Montreal), *Risk-Sensitive Control and Mean Field Games: A Variational Approach* (p. 163)
17:30 - 18:00	Borna Sayedana (McGill University), *Relative Almost Sure Regret Bounds for Certainty Equivalence Control of Markov Jump Systems* (p. 165)

Sunday December 3 dimanche 3 décembre

8:00 - 8:30	Yunus Emre Demirci (Queen's University), *On Regularity and Ergodicity of Partially Observable Markov (Decision) Processes* (p. 163)
8:30 - 9:00	Vijay Subramanian (University of Michigan), *Bayesian Learning of Optimal Policies in Markov Decision Processes with Countably Infinite State-Space* (p. 166)
9:00 - 9:30	Roland Malhame (University of Montreal), *A bottom-up approach to the construction of socially optimal discrete choices under congestion* (p. 164)
9:30 - 10:00	Ziteng Cheng (University of Toronto), *Mean field regret in discrete time games* (p. 162)
10:00 - 10:30	Bora Yongacoglu (University of Toronto), *Connections between POMDPs and partially observed n-player mean-field games* (p. 166)

Stochastic Control Theory and Applications
Théorie du contrôle stochastique et ses applications

Abstracts/Résumés

PETER CAINES, McGill University

[Saturday December 2 / samedi 2 décembre, 9:30 – UQAM - PK-1320]

Mean Field Games on Large Sparse and Dense Networks

Mean Field Game (MFG) theory treats the existence of Nash equilibria for large population dynamical games by approximating them with infinite population games of negligible agents. The MFG equations consist of the Hamilton-Jacobi-Bellman equation for the control of a generic agent and the Fokker-Planck-Kolmogorov equation describing its state evolution ; these are linked by the system's mean field, namely the state distribution of the generic agent.

Graphons are limits of node adjacency matrices (Lovasz, 2012). Graphon MFG (GMFG) systems (Caines and Huang, CDC 2018-19, SICON 2021) consist of MFGs where large nodal sub-populations interact over large dense graphs modelled in the limit by graphons. The solutions of the GMFG equations give a system's Nash equilibria and this permits an analysis of the optimality of the node dependent Nash values with respect to graphon index (Caines, Huang, Gao, Foguen-Tchuendom, CDC 2021,2022, MTNS 2022, IFAC 2023). This presentation of GMFG will use metric space embedded graph limits in the form of graphexons (Caines, CDC 2022). The formulation enables the modelling of limit networks situated in some compact space, M, by generalizing graphon functions on M x M to measures on M x M. This has the advantage of including both large sparse and dense networks ; furthermore, the resulting set-up permits meaningful differentiation of variables with respect to network location which is not the case for graphon based formulations.

Work with Alex Dunyak, Rinel Foguen-Tchuendom, Shuang Gao, Minyi Huang ; partially supported by NSERC (grant 2019-05336) and AFOSR (grant FA9550-23-1-0015).

MARGARET CHAPMAN, University of Toronto

[Saturday December 2 / samedi 2 décembre, 16:30 – UQAM - PK-1320]

Risk-Aware Control Theory

Risk-aware control theory is a fascinating subfield of stochastic control theory. This subfield concerns the analysis and control of dynamical systems with respect to a vast spectrum of possibilities between the average case and the worst case. The flexibility and generality offered by risk-aware control theory has broad significance because control systems often require an awareness of rare harmful possibilities without being overly cautious and different applications have different needs and preferences about managing uncertainty. Major early players in this area include David Jacobson (1970's) and Peter Whittle (1980's-1990's). There have been many exciting developments since those times, motivated by advances in finance and operations research in the early 2000's. In this talk, I plan to present an overview of risk-aware control theory along with the recent development of risk-aware safety analysis. This is joint work with Michael Fauss (Educational Testing Services, Princeton, NJ) and Kevin Smith (Environmental and Water Resources Engineering, Tufts University).

ZITENG CHENG, University of Toronto

[Sunday December 3 / dimanche 3 décembre, 9:30 – UQAM - PK-1320]

Mean field regret in discrete time games

We use mean field games (MFGs) to investigate approximations of N-player games with uniformly symmetrically continuous heterogeneous closed-loop actions. To incorporate agents' risk aversion (beyond the classical expected utility of total costs), we use an abstract evaluation functional for their performance criteria. Centered around the notion of regret, we conduct non-asymptotic analysis on the approximation capability of MFGs from the perspective of state-action distributions without requiring the uniqueness of equilibria. Under suitable assumptions, we first show that scenarios in the N-player games with large N and small average regrets can be well approximated by approximate solutions of MFGs with relatively small regrets. We then show that δ-mean field equilibria can be used to construct ε-equilibria in N-player games. Furthermore, in this general

setting, we prove the existence of mean field equilibria (MFEs). Our analysis above reveals an approximated refinement of N-player equilibria through MFEs. It also offers theoretical substantiation for algorithms that identify MFEs by minimizing regrets.

ASAF COHEN, University of Michigan
[Saturday December 2 / samedi 2 décembre, 9:00 – UQAM - PK-1320]
Deep Neural Networks Methods for Mean Field Game Master Equation

A mean field game (MFG) approximates a large-player symmetric game and its mean field equilibrium is fully characterized by the so-called master equation. The master equation is typically a non-linear, partial differential equation. While the master equation's well-posedness is known, an analytical solution is not known. What's more, classical discretization methods for solving the master equation suffer from the curse of dimensionality. In this joint work with Ethan Zell and Mathieu Lauriere, we study two algorithms to efficiently solve the master equation in many dimensions. We call one algorithm the Deep Backward Mean Field Game method (DBMFG) and the other is the Deep Galerkin Method (DGM) of Sirignano and Spiliopoulos. We provide novel proofs of the correctness of the algorithms. Due to the structure of the master equation, we cannot rely on the argument of Sirignano and Spiliopoulos for the correctness of the DGM in this application, nor can we rely on the proof of an analogous deep backward method introduced by Pham et. al. for the DBMFG. Instead, we use the structure of the MFG to overcome these difficulties. Time permitting, I will conclude with some of the numerical results.

YUNUS EMRE DEMIRCI, Queen's University
[Sunday December 3 / dimanche 3 décembre, 8:00 – UQAM - PK-1320]
On Regularity and Ergodicity of Partially Observable Markov (Decision) Processes

In this talk, we study time-homogeneous hidden Markov models where states are not directly observable, also known as partially observable Markov processes. Instead, these states are observed through a measurement channel. The initial state is determined by an initial distribution, and as new observations are made, we update the state's conditional probability measure given the measurements, leading to a nonlinear filtering process.

The focus of our study is on the regularity properties for these nonlinear filters under the Wasserstein metric. We present conditions which lead to geometric ergodicity, implying that the filter process converges to invariance at an exponential rate (as a probability measure valued Markov chain). While unique ergodicity of such filter processes had been studied in the literature, such a geometric ergodicity result appears to be new. We also provide complementary results on unique ergodicity for such models with continuous state spaces.

As an implication of our analysis for controlled hidden Markov models, we provide new conditions for the existence of solutions to the average cost optimality equation for Partially Observable Markov Decision Processes, for which only limited results are available in the literature. We furthermore discuss implications on robustness to incorrect priors

---

DENA FIROOZI, HEC Montréal - Université de Montréal
[Saturday December 2 / samedi 2 décembre, 17:00 – UQAM - PK-1320]
Risk-Sensitive Control and Mean Field Games: A Variational Approach

We develop a variational approach to address risk-sensitive optimal control problems with an exponential-of-integral cost functional in a general linear-quadratic-Gaussian (LQG) single-agent setup, offering new insights into such problems. Our analysis leads to the derivation of a nonlinear necessary and sufficient condition of optimality, expressed in terms of martingale processes. Subject to specific conditions, we find an equivalent risk-neutral measure, under which a linear state feedback form can be obtained for the optimal control. It is then shown that the obtained feedback control is consistent with the imposed condition and remains optimal under the original measure. Building upon this development, we (i) propose a variational framework for general LQG risk-sensitive mean-field games (MFGs) and (ii) advance the LQG risk-sensitive MFG theory by incorporating a major agent in the framework. The major agent interacts with a large number of minor agents, and unlike

the minor agents, its influence on the system remains significant even with an increasing number of minor agents. We derive the Markovian closed-loop best-response strategies of agents in the limiting case where the number of agents goes to infinity. We establish that the set of obtained best-response strategies yields a Nash equilibrium in the limiting case and an ε-Nash equilibrium in the finite-player case.

MINYI HUANG, Carleton University
[Saturday December 2 / samedi 2 décembre, 8:30 – UQAM - PK-1320]
Mean field social optimization: person-by-person optimality and master equations

We consider a large population optimal control problem and apply dynamic programming from the point of view of a representative agent, instead of directly treating a continuum of agents. This leads to a special HJB equation, called the master equation, for the value function of an agent. For performance analysis, we employ a two-scale master equation system to prove person-by-person optimality.

Joint work with

Shuenn-Jyi Sheu (National Central Uni. and National Chengchi Univ., Taiwan)

and Li-Hsien Sun (National Central Uni., Taiwan)

JOE JACKSON, The University of Chicago
[Saturday December 2 / samedi 2 décembre, 10:00 – UQAM - PK-1320]
Sharp convergence rates for mean field control on the region of strong regularity

This talk will be about the convergence of certain symmetric N-particle stochastic control problems towards their mean field limits. After a brief introduction to mean field control, we will mainly discuss the following question: how fast do the value functions V^N for the N-particle problems converge towards the value function U of the mean field problem ? Or in terms of partial differential equations - how fast do the solutions of certain finite-dimensional Hamilton-Jacobi-Bellman equations converge to the solution of a corresponding Hamilton-Jacobi-Bellman equation set on the space of probability measures ? If the data is smooth and convex, then U is smooth, and the rate is $O(1/N)$. When the data is not convex, U may fail to be smooth, and the answer is more subtle. On one hand, we know that the optimal global rate cannot be better than $O(1/\sqrt{N})$. On the other hand, a recent paper of Cardaliaguet and Souganidis identifies an open and dense set $\mathcal{O}$ of initial conditions (which we call the region of strong regularity, by analogy with some classical results on first order Hamilton-Jacobi equations) where U is smooth, and it is natural to wonder whether the rate of convergence might be better inside of $\mathcal{O}$. In an ongoing joint work with Cardaliaguet, Mimikos-Stamatopoulos, and Souganidis, we show that this is indeed the case: the rate is $O(1/N)$ locally uniformly inside the set $\mathcal{O}$, so the convergence is indeed faster inside $\mathcal{O}$ than it is outside.

ROLAND MALHAME, Ecole Polytechnique de Montréal
[Sunday December 3 / dimanche 3 décembre, 9:00 – UQAM - PK-1320]
A bottom-up approach to the construction of socially optimal discrete choices under congestion

We consider the problem of N agents having a limited time to decide on a destination choice among a finite number of alternatives D. The agents attempt to minimize collective energy expenditure while favoring motion strategies which limit crowding along their paths in the state space. This can correspond to a situation of crowd evacuation or a group of micro robots distributing themselves on tasks associated to distinct geographic locations. We formulate the problem as a Min linear quadratic optimal control problem with non positive definite Q matrices accounting for negative costs accruing from decreased crowding. The solution proceeds in three stages, each one improving on the performance of the previous stage: (i) Mapping optimal paths for an arbitrary agent destination assignment ; (ii) Mapping optimal paths for fixed fractions of agents assigned to each destination ; (iii) Identifying the optimal fraction of agents' assignments to each destination. The cost function associated with stage (iii), as N goes to infinity, is proven to be convex, leads to simplified computations and to epsilon-optimal decentralized control policies when applied for N large.

Stochastic Control Theory and Applications
Théorie du contrôle stochastique et ses applications

SOMNATH PRADHAN, Queen's University
[Saturday December 2 / samedi 2 décembre, 8:00 – UQAM - PK-1320]
Existence and Discrete-Time Approximations of Optimal Controls for Controlled Diffusions under General Information Structures

In this talk, we present existence and discrete-time approximation results on optimal control policies for continuous-time stochastic control problems under a variety of information structures. These include fully observed models, partially observed models and multi-agent models with decentralized information structures. While there exist comprehensive existence and approximations results for the fully observed setup in the literature, few prior research exists on discrete-time approximation results for partially observed models. For decentralized models, even existence results have not received much attention except for specialized models and approximation has been an open problem. Our existence and approximations results lead to the applicability of well-established partially observed Markov decision processes and the relatively more mature theory of discrete-time decentralized stochastic control to be applicable for computing near optimal solutions for continuous-time stochastic control.

This talk is based on joint work with Serdar Yüksel.

SINA SANJARI, Royal Military College of Canada / University of Illinois at Urbana-Champaign
[Saturday December 2 / samedi 2 décembre, 15:00 – UQAM - PK-1320]
Large Stochastic Exchangeable Teams, Their Mean-Field Limits, and Optimality of Symmetric Policies

Stochastic teams entail a collection of decision-makers acting together to optimize a common cost function but not necessarily sharing all the available information. We discuss a class of decentralized stochastic exchangeable teams with a finite number of decision-makers as well as their mean-field limits with infinite numbers of decision-makers.

We first consider convex teams. For this class of problems, we establish the existence of a globally optimal solution and show that it is symmetric (identical) for both the finite decision-maker regime and the infinite one. As the number of decision makers drives to infinity (that is for the mean-field limits), we establish the existence of a privately randomized globally optimal solution and show that it is symmetric among decision makers. For the class of non-convex exchangeable teams, we establish the existence of a globally optimal solution and show that it is exchangeable (the joint distribution is permutation invariant) and not necessarily symmetric for the finite decision-maker regime. For the infinite population regime, however, we show the existence of a globally optimal solution and establish that it is privately randomized and symmetric. Finally, we establish that a symmetric globally optimal solution for the mean-field problem is approximately optimal for the corresponding finite-population team with a large number of decision-makers.

BORNA SAYEDANA, McGill University
[Saturday December 2 / samedi 2 décembre, 17:30 – UQAM - PK-1320]
Relative Almost Sure Regret Bounds for Certainty Equivalence Control of Markov Jump Systems

In this talk, we consider the learning and control problem for unknown Markov jump linear systems (MJLS) with perfect state observations. We first establish an upper bound on regret for any learning-based algorithm. We then propose a certainty-equivalence based learning algorithm and show that this algorithm achieves a regret of $O(\sqrt{T}\log(T))$ relative to a certain subset of the sample space. As part of our analysis, we propose a switched least squares method for the identification of MJLS, show that this method is strongly consistent, and derive data-dependent and data-independent rates of convergence. These results show that certainty equivalence control along with the switched least squares method for MJLS has the same rate of convergence as the certainty equivalence control method for linear systems.

ZACHARY SELK, Queen's University
[Saturday December 2 / samedi 2 décembre, 16:00 – UQAM - PK-1320]
Robustness for Near-Brownian Noise via Rough Paths Theory

Stochastic Control Theory and Applications
Théorie du contrôle stochastique et ses applications

One frequent modelling choice made in stochastic control is assuming that the noise is a Brownian motion. However, this is only an idealization. For example, Kushner argues that "wide-band" Brownian motion is much more physical because the high frequencies are often not present. Another example is the fractional Brownian motion which can be seen as the generalization of Brownian motion to allow for correlations in the increments. There are several other "near-Brownian" but not actually Brownian driving signals which lead to questions of robustness. That is - if we assume an idealized Brownian noise apply the optimal policy to a real situation, are we near optimal ? We show that the answer is yes, using rough paths theory.

Rough paths theory was in invented in the 1990s by Terry Lyons as an alternative to the standard Itô theory. One of the issues with Itô theory is a lack of continuity in the driving noise. Another issue with Itô theory is that it only allows for semimartingale noise. This disallows noise such as fractional Brownian motion. One further issue is that Itô theory is not defined pathwise - only as limits in L^2. The key insight of rough paths theory is that by enhancing the driving signal with its "iterated integrals", continuity to the solution map is restored and a wide range of signals can be integrated.

In this talk, we introduce the basics of rough paths theory and discuss a robustness result. Joint with Somnath Pradhan and Serdar Yüksel.

VIJAY SUBRAMANIAN, University of Michigan, Ann Arbor

[Sunday December 3 / dimanche 3 décembre, 8:30 – UQAM - PK-1320]

Bayesian Learning of Optimal Policies in Markov Decision Processes with Countably Infinite State-Space

Models of many real-life applications—queuing models of communication networks—have a countably infinite state-space. Algorithmic and learning procedures that have been developed to produce optimal policies mainly focus on finite state settings, and do not apply to these models. To overcome this lacuna, we study the problem of optimal control of a family of discrete-time countable state-space Markov Decision Processes (MDPs) governed by an unknown parameter $\theta \in \Theta$, and defined on a countably-infinite state space $\mathcal{X} = \mathbb{Z}_+^d$, with finite action space $\mathcal{A}$, and an unbounded cost function. The random unknown parameter θ^* is generated via a given fixed prior distribution on Θ. To optimally control the unknown MDP, we propose an algorithm based on Thompson sampling with dynamically-sized episodes: at the beginning of each episode, the posterior distribution formed via Bayes' rule is used to produce a parameter estimate, which then decides the policy applied during the episode. To ensure the stability of the Markov chain obtained by following the policy chosen for each parameter, we impose ergodicity assumptions. From this condition and using the solution of the average cost Bellman equation, we establish an $\tilde{O}(\sqrt{|\mathcal{A}T})$ upper bound on the Bayesian regret of our algorithm, where T is the time-horizon. Finally, to elucidate the applicability of our algorithm, we consider two different queuing models with unknown dynamics, and show that our algorithm can be applied to develop approximately optimal control algorithms.

This is joint work with Saghar Adler at the University of Michigan, Ann Arbor.

JOHANNES WIESEL, Carnegie Mellon University

[Saturday December 2 / samedi 2 décembre, 15:30 – UQAM - PK-1320]

Martingale Schrödinger bridges

In a two-period financial market where a stock is traded dynamically and European options at maturity are traded statically, we study the so-called martingale Schrödinger bridge Q* ; that is, the minimal-entropy martingale measure among all models calibrated to option prices. This minimization is shown to be in duality with an exponential utility maximization over semistatic portfolios. Under a technical condition on the physical measure P, we show that an optimal portfolio exists and provides an explicit solution for Q*. This result overcomes the remarkable issue of non-closedness of semistatic strategies discovered by Acciaio, Larsson and Schachermayer.

This talk is based on joint work with Marcel Nutz and Long Zhao.

BORA YONGACOGLU, University of Toronto

[Sunday December 3 / dimanche 3 décembre, 10:00 – UQAM - PK-1320]

Connections between POMDPs and partially observed n-player mean-field games

Stochastic Control Theory and Applications
Théorie du contrôle stochastique et ses applications

In this talk, we will study a discrete-time model of mean-field games with finitely many players and partial observability of the global state, and we will describe the deep connection between such n-player mean-field games and partially observed Markov decision problems (POMDPs). We focus primarily on settings with mean-field observability, where each player privately observes its own local state as well as the complete mean-field distribution. We prove that if one's counterparts use symmetric stationary memoryless policies, then a given agent faces a fully observed, time homogenous MDP. We leverage this to prove the existence of a memoryless, stationary perfect equilibrium in the n-player game with mean-field observability. We also show that the symmetry condition cannot be relaxed without loss of generality. Under narrower observation channels, in which the mean-field information is compressed before being observed by each agent, we show that the agent faces a POMDP rather than an MDP, even when its counterparts use symmetric policies.

Student Research Session
Séance de recherche étudiante

Org: Karen Julia Fletcher (Athabasca University) and/et **Daniel Zackon** (McGill University)

Schedule/Horaire **Room/Salle: Symphonie 2B**

Sunday December 3 / dimanche 3 décembre

15:00 - 15:30	Stéphanie Abo (Waterloo), *Sex-specific mathematical models of energy metabolism during exercise* (p. 168)
15:30 - 16:00	Adriana-Stefania Ciupeanu (Manitoba), *Dynamics of Variants of Concern* (p. 168)
16:00 - 16:30	Nahid Sadr (Sherbrooke), *Index-mixed copulas* (p. 170)
16:30 - 17:00	Alexander Kroitor (Waterloo) (p. 169)
17:00 - 17:30	Scott Wesley (Dalhousie), *Towards an Algebraic and Geometric Theory of Quantum Circuits* (p. 170)
17:30 - 18:00	Shreya Dhar, Chenglu Wang, Grayson Plumpton & River Newman (Toronto, Pennsylvania, Queen's, Yale), *On the Classification of Field Extensions of p-adic Fields* (p. 169)

Monday December 4 / lundi 4 décembre

8:00 - 8:30	Christopher James Lang (Waterloo), *Spherically symmetric hyperbolic monopoles* (p. 169)
8:30 - 9:00	Chaabane Rejeb (Sherbrooke), *Quasi-homogeneous solutions to the WDVV equations associated with the genus one Hurwitz-Frobenius manifolds.* (p. 170)
9:00 - 9:30	Fadia Ounissi (Concordia), *On Rogers-Shephard type inequalities for (n-1)-dimensional volumes* (p. 169)
9:30 - 10:00	Haggai Liu (SFU), *Moduli Spaces of Weighted Stable Curves and their Fundamental Groups* (p. 169)
10:00 - 10:30	Tonatiuh Matos Wiederhold (Toronto), *The lattice of uniform topologies* (p. 171)

Abstracts/Résumés

STÉPHANIE ABO, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 15:00 – Symphonie 2B]
Sex-specific mathematical models of energy metabolism during exercise

Women oxidize significantly more lipids and significantly less carbohydrates than men during endurance exercise. This sexual dimorphism in energy metabolism has been attributed in part to observed differences in epinephrine and glucagon levels during exercise between men and women. To identify the candidate mechanisms for this sex difference, we created a sex-specific multi-scale mathematical model that links cellular metabolism in organs to whole-body responses during exercise. Model simulations show that the female liver, which tends to preserve hepatic glycogen stores, is primarily responsible for the shift toward lipid metabolism. Furthermore, skeletal muscle in females uses plasma free fatty acids as its primary fuel source rather than intramyocellular lipids, whereas the opposite holds true for males.

ADRIANA-STEFANIA CIUPEANU
[Sunday December 3 / dimanche 3 décembre, 15:30 – Symphonie 2B]
Dynamics of Variants of Concern

Abstract: The COVID-19 pandemic has seen multiple waves, in part due to the implementation and relaxation of social distancing measures by the public health authorities around the world, and also caused by the emergence of new variants of concern (VOCs) of the SARS-Cov-2 virus. Using mathematical modelling tools, we investigated the dynamics of VOCs with the objective of understanding key factors that determine the dominance and coexistence of VOCs. Our results show that the transmissibility advantage of a new VOC is a main factor for it to become dominant. Additionally, our modelling study indicates

that the initial number of people infected with the new VOC plays an important role in determining the size of the epidemic. Furthermore, public health measures targeting the newly emerging VOC taken in the early phase of its spread can limit the size of the epidemic caused by the new VOC. This is joint work with Marie Varughese, Weston Roda, Donglin Han, Qun Cheng, Michael Y. Li

---

SHREYA DHAR, CHENGLU WANG, GRAYSON PLUMPTON & RIVER NEWMAN, U of T (Shreya), UPenn (Chenglu), Yale (River), and Queens (Grayson)
[Sunday December 3 / dimanche 3 décembre, 17:30 – Symphonie 2B]
On the Classification of Field Extensions of p-adic Fields

Let p be a prime and let $\mathbb{Q}_p$ be the field of p-adic numbers. It is known that the finite extensions of $\mathbb{Q}_p$ of a given degree are finite up to isomorphism. Given a cubic field extension L of $\mathbb{Q}_p$ generated by the root of an irreducible polynomial h, we present a practical (closed-form) method to determine the isomorphism class in which L lives, based on the coefficients of h. We will discuss the subtleties of the case when the degree of the extension coincides with p, the characteristic of the residue field. Further, we draw connections to an application of this classification in the classification of conjugacy classes of elliptic tori in $\mathrm{Sp}(6, \mathbb{Q}_p)$.

ALEXANDER KROITOR, Waterloo
[Sunday December 3 / dimanche 3 décembre, 16:30 – Symphonie 2B]

CHRISTOPHER JAMES LANG, University of Waterloo
[Monday December 4 / lundi 4 décembre, 8:00 – Symphonie 2B]
Spherically symmetric hyperbolic monopoles

Hyperbolic monopoles are solutions to the Bogomolny equations, a system of partial differential equations on hyperbolic 3-space, though few examples exist. Using a correspondence with circle-invariant instantons, we reduce the problem of finding spherically symmetric hyperbolic monopoles (solving differential equations) to a problem in the realm of representation theory, providing much needed examples of these objects.

HAGGAI LIU, Simon Fraser University
[Monday December 4 / lundi 4 décembre, 9:30 – Symphonie 2B]
Moduli Spaces of Weighted Stable Curves and their Fundamental Groups

The Deligne-Mumford compactification, $\overline{M_{0,n}}$, of the moduli space of n distinct ordered points on $\mathbb{P}^1$, has many well understood geometric and topological properties. For example, it is a smooth projective variety over its base field. Many interesting properties are known for the manifold $\overline{M_{0,n}}(\mathbb{R})$ of real points of this variety. In particular, its fundamental group, $\pi_1(\overline{M_{0,n}}(\mathbb{R}))$, is related, via a short exact sequence, to another group known as the cactus group. Henriques and Kamnitzer gave an elegant combinatorial presentation of this cactus group.

We study a weighted variant of $\overline{M_{0,n}}(\mathbb{R})$ known as a Hassett space: For each of the n labels, we assign a weight between 0 and 1 ; points can coincide if the sum of their weights does not exceed one. Our goal is to find combinatorial presentations for the fundamental groups of Hassett spaces with certain restrictions on the weights. To proceed with our goal, we use two main approaches: The first approach is to recursively compute them using blowups, Seifert Van-Kampen, and knowledge for smaller n. The second approach is to express the Hassett space as a blow-down of $\overline{M_{0,n}}$ and modify the cactus group directly.

FADIA OUNISSI, Concordia University
[Monday December 4 / lundi 4 décembre, 9:00 – Symphonie 2B]
On Rogers-Shephard type inequalities for (n-1)-dimensional volumes

Student Research Session
Séance de recherche étudiante

The difference body $K-K$ of a convex body $K \in \mathbb{R}^n$, formed by taking the Minkowski sum of K and $-K$, has been extensively studied, notably following the conjectured Rogers-Shephard inequality, $V_n(K-K) \leq \binom{2n}{n} V_n(K)$, with equality if and only if K is a simplex. Although this inequality holds for n-dimensional volumes, very little is known about the upper bound for the $(n-1)$-dimensional volume of $K-K$. In this talk, we first introduce some preliminaries on convex analysis, and discuss our asymptotic upper bound for $\frac{V_{n-1}(K-K)}{V_{n-1}(K)}$, supported by estimates for some classes of polytopes and nonsmooth bodies in $\mathbb{R}^3$.

CHAABANE REJEB, Université de Sherbrooke

[Monday December 4 / lundi 4 décembre, 8:30 – Symphonie 2B]

Quasi-homogeneous solutions to the WDVV equations associated with the genus one Hurwitz-Frobenius manifolds.

We consider the genus one Hurwitz space of ramified coverings of the Riemann sphere with prescribed ramification profile over the point at infinity. We construct on Hurwitz spaces a family of Frobenius manifold structures associated with the quasi-homogeneous differentials. We explicitly derive new generating formulas for the corresponding prepotentials. This produces quasi-homogeneous solutions to the following generalized WDVV associativity equations: $F_i \eta^{-1} F_j = F_j \eta^{-1} F_i$, where the invertible constant matrix η is a linear combination of the matrices F_j. As applications, we obtain explicit solutions to the WDVV equations in genus one and give a new proof of Ramanujan's differential equations for the Eisenstein series E_2, E_4 and E_6.

NAHID SADR, Université de Sherbrooke

[Sunday December 3 / dimanche 3 décembre, 16:00 – Symphonie 2B]

Index-mixed copulas

Copulas provide a framework for modeling dependence between random variables. They are particularly important in multivariate statistics and risk management, as they help model the relationship between variables while accounting for their marginal distributions. In this talk, we aim to introduce the basics of copula theory, how copulas relate to multivariate joint distributions via the celebrated Sklar's theorem, and compare some families of copulas studied in the literature that are used in theory and practice to capture different dependence scenarios. Afterwards, our research on a new class of copulas named index-mixed copulas is introduced, and its properties are investigated. Index-mixed copulas are constructed from given base copulas and a random index vector, and show a rather remarkable degree of analytical tractability. The analytical form of the copula and, if it exists, its density is derived. As the construction is based on a stochastic representation, sampling algorithms can be given. Properties investigated include bivariate and trivariate margins, tail dependence, measures of concordance such as Spearman's rho or Kendall's tau, and concordance orderings. A particularly interesting feature of index-mixed copulas is that they allow one to provide an interpretation of the well-known family of Eyraud-Farlie-Gumbel-Morgenstern (EFGM) copulas, which are popular for their analytical tractability. Through the lens of index-mixing, one can see EFGM copulas can only model a limited range of concordance and are tail independent, but this is not the case for index-mixed copulas in general.

SCOTT WESLEY, Dalhousie Unviersity

[Sunday December 3 / dimanche 3 décembre, 17:00 – Symphonie 2B]

Towards an Algebraic and Geometric Theory of Quantum Circuits

The circuit diagrams studied in computer science enjoy a rich mathematical theory. Given a finite set of primitive operators (known as "gates"), a circuit diagram is any operator obtained by composing finitely many gates in sequence or in parallel. Formally, circuits correspond to string diagrams in finitely-generated monoidal categories. A special class of circuit diagrams are the classical reversible circuits, in which gates are invertible matrices over $\mathbb{Z}_2$. It was shown by Toffoli in 1980 that every classical reversible circuit is constructible from a single primitive known as the Toffoli gate. More generally, one can study monoidal groupoids, which characterize all reversible models of computation. For example, the reversible quantum circuits studied by Feynman correspond to the monoidal groupoid of unitary matrices. Since unitary matrices are uncountable, there does not exist an exact universal gate set for quantum computation. However, given both the Toffoli and Hadamard gate, all unitary operators can be simulated.

This talk begins with an introduction to combinatorial circuits as symmetric monoidal string diagrams. The case of classical reversible circuits is recalled. It is then shown how quantum mechanics gives rise to a groupoid of reversible circuits subsuming the classical case. The homsets in this category form groups of circuits with identical wire counts. Presentations for these groups can answer many questions in quantum computing. As a specific example, the 3-qubit dyadic Toffoli+H circuits are considered, whose presentation emerges from the E8 lattice. This presentation, in turn, yields information about the entire sub-groupoid of dyadic Toffoli+H circuits.

TONATIUH MATOS WIEDERHOLD, University of Toronto
[Monday December 4 / lundi 4 décembre, 10:00 – Symphonie 2B]
The lattice of uniform topologies

Given a Tychonoff space X (e.g., the reals), there are many ways to topologize $C(X)$, the space of continuous functions from X to $\mathbb{R}$. If we order a specific family of uniform topologies appropriately, we get an atomic complete lattice with many interesting properties, some of which can be used to study the original space X itself. In this talk, we give an introduction to this lattice, discuss some curious properties, open problems and recent discoveries, followed by an invitation to explore this exciting new field.

This is joint work in progress with Dr. Roberto Pichardo Mendoza.

Supporting Numeracy for Non-STEM Students
Supporter la numératie pour les étudiants non-STIM

Org: Kseniya Garaschuk and/et **Vanessa Radzimski** (University of the Fraser Valley)

Numeracy is a complex notion encompassing many dimensions that contribute to students' mathematical understanding. The methods employed to enhance numeracy learning in the classroom must align with the specific facets of numeracy being prioritized and nurtured. In this session, educators will share their insights on the specific dimensions of numeracy that significantly inform their practice. Presenters will address the ways in which they support the development of numeracy skills in their students from a variety of disciplines, including students that are pre-service and in-service teachers at the elementary and secondary levels. Join us as we explore strategies for supporting flexible, proficient, and contextual understandings of mathematics through numeracy. This session is supported by Callysto project.

Schedule/Horaire **Room/Salle: Grand Salon Opera A**

Sunday December 3 **dimanche 3 décembre**

8:00 - 8:30	Networking Meet and Greet (p. 174)
8:30 - 9:00	Miroslav Lovric (McMaster), *Why numeracy should have a life of its own* (p. 173)
9:00 - 9:30	Nahid Walji (University of British Columbia), *Mathematics and Numeracy for Liberal Arts Students* (p. 174)
9:30 - 10:00	Asia Matthews, *Combining Numeracy and Rhetoric in an Interdisciplinary Modelling Course* (p. 173)
10:00 - 10:30	Anton Mosunov and Gavin Orok (University of Waterloo), *Assessing the Effect of an Illustrated Storybook on Correcting Common Misconceptions About Mathematics* (p. 174)
15:00 - 15:30	Ed Doolittle (First Nations University of Canada), *Numeracy for Indigenous Teacher Candidates* (p. 172)
15:30 - 16:00	Andrea Hyde (College of the Rockies), *Numeracy in Pre-Ed Students in Rural BC* (p. 173)
16:00 - 16:30	Viktor Freiman (University of Moncton), *New Brunswick path to numeracy in technology-rich environments: what elementary school teachers should be aware of ?* (p. 172)
16:30 - 17:00	Christine Suurtamm (University of Ottawa), *Equity and Mathematics Teaching and Learning* (p. 174)
17:00 - 17:30	Fok Shuen Leung (University of British Columbia), *Poetry without Grammar* (p. 173)
17:30 - 18:00	Open Discussion (p. 174)

Abstracts/Résumés

ED DOOLITTLE, First Nations University of Canada

[Sunday December 3 / dimanche 3 décembre, 15:00 – Grand Salon Opera A]

Numeracy for Indigenous Teacher Candidates

In the Indigenous Education program at First Nations University of Canada, elementary teacher candidates must all take MATH 101: Introductory Finite Mathematics I, a general interest, terminal course in mathematics taken by all University of Regina Education and Arts students. We have modified the course to cover topics and examples of importance to Indigenous teachers, some of which will be discussed in this presentation.

VIKTOR FREIMAN, Université de Moncton

[Sunday December 3 / dimanche 3 décembre, 16:00 – Grand Salon Opera A]

New Brunswick path to numeracy in technology-rich environments: what elementary school teachers should be aware of ?

There are two recent trends in New Brunswick (NB) inclusive schools that require attention of elementary teacher educators: numeracy shift in K-12 mathematics curriculum and increasing role of technology via the use of tangible digital devices, robotics,

3D printing, and coding platforms (Freiman, 2022). More recently, data literacy and big data add other opportunities. How should it impact teachers' professional learning ? Based on the in-school research on technology-rich environments, such as makerspaces and flexible classrooms (LeBlanc, Freiman, and Furlong, 2022 ; Chiasson and Freiman, 2022), numerous workshops with teachers and schoolchildren, as well as integration of technology into undergraduate courses in mathematics education at Université de Moncton, we will discuss how technology changes the nature of mathematics, its relation to numeracy and the way how mathematics is taught and learned in the 21st century to become more real-life connected, hands-on, interdisciplinary, and transdisciplinary and what type of support is needed for teachers to take an advantage of these experiences.

ANDREA HYDE, College of the Rockies
[Sunday December 3 / dimanche 3 décembre, 15:30 – Grand Salon Opera A]
Numeracy in Pre-Ed Students in Rural BC

In this presentation I will explore the relationship between numeracy, Polya's problem solving process, and math anxiety in pre-education students at a small, rural BC teaching college. The focus of this talk is my practices and experiences with my students.

FOK SHUEN LEUNG, University of British Columbia
[Sunday December 3 / dimanche 3 décembre, 17:00 – Grand Salon Opera A]
Poetry without Grammar

We tell novice instructors that big ideas matter – that math is a technical subject, certainly ; but that unless the tools and techniques orient toward big and beautiful ideas, we are technical advisors, teaching all grammar and no poetry. First-year Math students have years of experience being rewarded for doing calculations well ; we need to remind them that calculations can be meaningful.

But what happens when we encounter students who don't even have the grammar experience ? This talk explores recent experiences in a course aimed at such students. Can we teach poetry without grammar ? Should we ?

MIROSLAV LOVRIC, McMaster University
[Sunday December 3 / dimanche 3 décembre, 8:30 – Grand Salon Opera A]
Why numeracy should have a life of its own

In this talk I will discuss the design and teaching of my university-level numeracy course "Numbers for Life," to outline the benefits of viewing numeracy as an entity separate from (but of course, tied to) mathematics. Whereas mathematics involves thinking $about$ numbers, numeracy (guided by the context of the situation) involves thinking $with$ numbers. To support my arguments, I will contrast numeracy tasks with mathematical tasks, and emphasize the importance of the transfer from "school mathematics" to "real-world" problems.

ASIA MATTHEWS
[Sunday December 3 / dimanche 3 décembre, 9:30 – Grand Salon Opera A]
Combining Numeracy and Rhetoric in an Interdisciplinary Modelling Course

I have always been interested in the similarities and differences between numeracy/quantitative reasoning and mathematics: I initiated a "numeracy week" at an Ontario elementary school six years ago, I continue to provide mathematics enrichment to school kids and teachers, and during my time at Quest I supported the challenge of distinguishing our QR program from the mathematics curriculum. At Quest, QR and Rhetoric were the foundational streams for our Arts and Sciences BA degree, threading throughout the interdisciplinary curriculum. But they weren't everywhere. And our students weren't challenged to strengthen both skills consistently. The mathematician in me thought to pose myself a wee problem: what would a *really good* course focused on numeracy and rhetoric skills rhetoric look like ? Completely unrelated, I was inspired by Yvan's description

of a modelling course at the 2019 FYMSiC meeting and thought to design such a course for Quest. Only later did I realize that the way I designed this modelling course answered the problem. In this talk I'll explain the design and implementation of an interdisciplinary modelling course which effectively draws out numeracy and rhetoric skills in concert.

NETWORKING MEET AND GREET,
[Sunday December 3 / dimanche 3 décembre, 8:00 – Grand Salon Opera A]

ANTON MOSUNOV AND GAVIN OROK, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 10:00 – Grand Salon Opera A]
Assessing the Effect of an Illustrated Storybook on Correcting Common Misconceptions About Mathematics

Innumeracy is rarely not accompanied by mathematical anxiety, and many factors contribute to its formation. For example, students may have difficulty caring about the subject because of how abstract and disconnected from real life it may appear, leading to them being less engaged in their classes. In addition, women can feel outnumbered in their mathematics classes and are discouraged from pursuing STEM careers because they see fewer female role models in math. These aspects often lead to fewer students pursuing math courses, resulting in lower academic performance.

On the other hand, having a growth mindset has a positive effect on performance in math, including numeracy. With a team of writers and artists we've authored an illustrated storybook whose goal is to help students to develop a growth mindset towards mathematics and address some common misconceptions about it. Our book contains a number of exercises, including basic ones on primes, that are accompanied by visual aids to engage the readers in the young target audience. In our presentation we will present the book and introduce our research project, which aims to assess the effect of our storybook on correcting misconceptions about mathematics among first- and second-year undergraduate students. Our research project has been given ethics clearance and will commence in Winter 2024.

OPEN DISCUSSION,
[Sunday December 3 / dimanche 3 décembre, 17:30 – Grand Salon Opera A]

CHRISTINE SUURTAMM, Faculty of Education, University of Ottawa
[Sunday December 3 / dimanche 3 décembre, 16:30 – Grand Salon Opera A]
Equity and Mathematics Teaching and Learning

This presentation will challenge the notion of labeling students in Grades K – 12 as being non-STEM students. Rather, it will examine ways that teachers and students can see themselves as mathematically capable and engage in STEM subjects. Seeing the teaching and learning of mathematics through an equity lens means teaching in ways that can engage all students and allow all students to tackle mathematics problems in various ways that draw on their own experiences. Examples will be drawn from the current Grade 1 – 9 mathematics curriculum in Ontario, including its initiative of a destreamed Grade 9 mathematics course. Not only will it look at the curriculum but it will also discuss teaching practices that aim to get all students involved in mathematical thinking.

NAHID WALJI, UBC
[Sunday December 3 / dimanche 3 décembre, 9:00 – Grand Salon Opera A]
Mathematics and Numeracy for Liberal Arts Students

There are many courses aimed at liberal arts students that are specifically designed to fulfil their mathematics requirement, including courses with titles such as "Math for Life" or "Math for Liberal Arts". These have two main goals: the first is to ensure a sufficient level of numeracy amongst such students and the second is to enable the development of a positive attitude

towards mathematics. These courses are often the last classroom experience of mathematics that such students will have, and therefore can have a long-term impact on their comfort level and opinions of mathematics. I have experimented with different teaching approaches at various institutions, aiming to strike a balance between emphasising practical skills and exploring more advanced topics to improve student engagement. In this talk I will describe my experiences and challenges in teaching these students, share how they changed preconceptions about non-STEM students, and discuss approaches that were successful.

The many facets of random matrix theory

Org: Lucas Benigni (Université de Montréal), **Elizabeth Collins-Woodfin** (McGill) and/et **Elliot Paquette** (McGill)

The goal of the meeting is to bring together researchers in random matrix theory, in its many different forms, to share different techniques, perspectives and stoke creativity in new problems and collaborations. We have intentionally selected for a wide range of topics: • Dyson Brownian motion and other Markov processes on random matrices and their application to universality. • Beta-ensembles, and their connection to log-correlated fields. • Connections of random matrix theory to spin glass theory and high-dimensional statistics. • The random matrix theory of random graphs and discrete random matrices. • Free probability, the theory of multiple random matrices, and the matrix Dyson equation.

Schedule/Horaire — Room/Salle: Imagination

Saturday December 2 — samedi 2 décembre

8:30 - 9:00	Vishesh Jain (University of Illinois at Chicag), *Invertibility of random matrices* (p. 177)
9:00 - 9:30	James Mingo (Queen's University), *Infinitesimal Operators* (p. 178)
9:30 - 10:00	David Renfrew (Binghamton University), *Eigenvalues of minors of random matrices and roots of derivatives of random polynomials* (p. 179)
10:00 - 10:30	Aaron Smith (University of Ottawa), *Kac's Walk on SO(n) and Related Chains* (p. 179)
15:00 - 15:30	Giorgio Cipolloni (Princeton University), *Logarithmically correlated fields in non-Hermitian random matrices* (p. 176)
15:30 - 16:00	Benjamin Landon (University of Toronto), *Regularity conditions in the CLT for random matrices* (p. 177)
16:00 - 16:30	Andras Meszaros (University of Toronto), *Eigenvectors of the square grid plus GUE* (p. 178)
16:30 - 17:00	Luke Peilen (Temple University), *Local Laws and Fluctuations for Log Gases* (p. 178)

Sunday December 3 — dimanche 3 décembre

8:30 - 9:00	Hugo Latourelle-Vigeant (McGill University), *Matrix Dyson Equation for Correlated Linearizations* (p. 177)
9:00 - 9:30	Justin Ko (University of Waterloo), *Spectral Phase Transitions in Non-Linear Wigner Spiked Models* (p. 177)
9:30 - 10:00	Jonathan Husson (University of Michigan), *Generalized empirical covariance matrices and large deviations.* (p. 176)
10:00 - 10:30	Vincent Painchaud (McGill University), *Convergence of the stochastic Airy operator to the stochastic sine operator* (p. 178)

Abstracts/Résumés

GIORGIO CIPOLLONI, Princeton University
[Saturday December 2 / samedi 2 décembre, 15:00 – Imagination]
Logarithmically correlated fields in non-Hermitian random matrices

We prove that for matrices with i.i.d. entries the fluctuations of their eigenvalues converge to a 2D log-correlated field. We study the extremal value of this field and demonstrate its logarithmic dependence on the matrix dimension. I will then explain how a 3D log-correlated field naturally emerges from dynamics on non-Hermitian matrices.

The many facets of random matrix theory

JONATHAN HUSSON, University of Michigan
[Sunday December 3 / dimanche 3 décembre, 9:30 – Imagination]
Generalized empirical covariance matrices and large deviations.

In many applications of random matrix theory, such as Principal Component Analysis or the study of random landscapes, the behavior of the largest eigenvalue is of particular importance. In this talk, we will consider a model of generalized empirical covariance matrix and we will state a large deviation principle for its largest eigenvalue. The main tool of the proof is the use of a spherical integral of rank one as a proxy for this largest, eigenvalue. This makes possible to tackle not only Gaussian entries but also so-called "sharp sub-Gaussian" entries such as Rademacher random variables. We then have a universality phenomenon - which is rather surprising in the large deviation regime - as well as an elegant representation for the rate function. This talk is based on a collaboration with Ben McKenna.

VISHESH JAIN, University of Illinois Chicago
[Saturday December 2 / samedi 2 décembre, 8:30 – Imagination]
Invertibility of random matrices

Motivated by applications to numerical analysis and the study of the limiting spectral distribution of random matrices, the fundamental problem of establishing the invertibility of random square matrices and providing accompanying lower-tail estimates for the smallest singular value has been intensely studied, especially during the past 20 years. In this talk, we will survey some recent developments in this area from the past few years and highlight possible directions for future investigation.

JUSTIN KO, University of Waterloo
[Sunday December 3 / dimanche 3 décembre, 9:00 – Imagination]
Spectral Phase Transitions in Non-Linear Wigner Spiked Models

In this talk, we discuss the asymptotic behavior of the spectrum of a random matrix where a non-linearity is applied entry-wise to a Wigner matrix perturbed by a rank-one spike with independent and identically distributed entries. In this setting, we show that when the signal-to-noise ratio scale as $N^{\frac{1}{2}(1-1/k_\star)}$, where $k_\star$ is the first non-zero generalized information coefficient of the function, the non-linear spike model effectively behaves as an equivalent spiked Wigner matrix, where the former spike before the non-linearity is now raised to a power $k_\star$. This allows us to study the phase transition of the leading eigenvalues, generalizing part of the work of Baik, Ben Arous and Péché to these non-linear models. We also will explain an application of this result to estimate a low-rank matrix from non-linear and possibly noisy observations. This talk is based on recent and upcoming work with Alice Guionnet, Florent Krzakala, Pierre Mergny, and Lenka Zdeborová.

BENJAMIN LANDON, University of Toronto
[Saturday December 2 / samedi 2 décembre, 15:30 – Imagination]
Regularity conditions in the CLT for random matrices

A classical result in random matrix theory is that for wide classes of Hermitian matrices, Linear Spectral Statistics of the form $\sum_{i=1}^{N} f(\lambda_i)$ have asymptotic Gaussian fluctuations in the limit of large dimension $N \to \infty$. For Wigner matrices, the limiting variance is a Sobolev-type norm, the $H^{1/2}$ norm of the function expressed in the basis of Chebyshev polynomials. Conjecturally, the CLT should hold as soon as the expression for the limiting variance is finite, but most results on the CLT require significantly stricter regularity conditions. In this talk we will review recent progress on this conjecture.

Joint work with P. Sosoe.

The many facets of random matrix theory

HUGO LATOURELLE-VIGEANT, McGill
[Sunday December 3 / dimanche 3 décembre, 8:30 – Imagination]
Matrix Dyson Equation for Correlated Linearizations

The exploration of large random matrices through asymptotic deterministic equivalents has been approached by a multitude of techniques. One approach employs the matrix Dyson equation to establish an asymptotic equivalence between a random resolvent and the solution of a matrix fixed point equation. Another, the linearization trick, has proven effective in studying rational functions of random matrices. This trick involves embedding a matrix expression into a larger random matrix, known as a linear matrix pencil, with a simplified correlation structure.

In this presentation, we introduce an extension of the matrix Dyson equation framework tailored specifically for linearizations. This extends previous work which has focused primarily on the case of pencils with blocks of canonical Wigner or Circular type. Within this framework, we derive an anisotropic global law for a broad class of pseudo-resolvents with general correlation structures. To highlight the practical implications of our framework, we apply it to a problem coming from machine learning. Specifically, we apply it to derive an exact asymptotic expression for the validation error of random features ridge regression and establish a general Gaussian equivalence result.

ANDRAS MESZAROS, University of Toronto
[Saturday December 2 / samedi 2 décembre, 16:00 – Imagination]
Eigenvectors of the square grid plus GUE

Eigenvectors of the GUE-perturbed discrete torus with uniform boundary conditions retain some product structure for small perturbations but converge to discrete Gaussian waves for large perturbations. We determine where this phase transition happens. Joint work with Balint Virag.

JAMES MINGO, Queen's UNiversity
[Saturday December 2 / samedi 2 décembre, 9:00 – Imagination]
Infinitesimal Operators

In this talk (which is joint work with Pei-Lun Tseng (NYU Abu Dhabi)) I will show that free independence can be adapted to give spectral results on finite rank perturbations of unitarily invariant matrix ensembles.

The main concepts are that of an infinitesimal operator (the finite rank perturbation) and infinitesimal free independence. Free independence is Voiculescu's adaptation of independence to non-commuting random variables based on free products, and infinitesimal independence is a stronger form of free independence. Free independence has become in recent years one of the main tools in analyzing the eigenvalue distribution of sums and products of random matrices.

I will apply this to the commutator and anti-commutator of independent operators.

VINCENT PAINCHAUD, McGill University
[Sunday December 3 / dimanche 3 décembre, 10:00 – Imagination]
Convergence of the stochastic Airy operator to the stochastic sine operator

The Airy and sine point processes describe the behavior of eigenvalues of random matrices from beta-ensembles when scaled at the soft edge and at the bulk respectively. These two point processes can be described as the spectra of two stochastic differential operators called the stochastic Airy and sine operators. It is known that in a suitable scaling limit, the Airy point process converges in distribution to the sine point process. In this talk, we present an operator-level version of this convergence. More precisely, we represent the stochastic Airy and sine operators as random canonical systems, and we show that, when seen as measures, their coefficient matrices converge weakly in distribution. This talk is based on joint work with Elliot Paquette.

The many facets of random matrix theory

LUKE PEILEN, Temple University
[Saturday December 2 / samedi 2 décembre, 16:30 – Imagination]
Local Laws and Fluctuations for Log Gases

We study the statistical mechanics of the log-gas, or β-ensemble, for general potential and inverse temperature. By means of a bootstrap procedure, we prove local laws on a next order energy that are valid down to microscopic length scales. To our knowledge, this is the first time that this kind of a local quantity has been controlled for the log-gas. Simultaneously, we exhibit a control on fluctuations of linear statistics that is valid at all mesoscales. Using these local laws, we are able to exhibit for the first time a CLT at arbitrary mesoscales, improving upon a previous result of Bekerman-Lodhia that was true only for power mesoscales.

The approach that we use generalizes well to the study of Riesz gases in higher dimensions. Time permitting we will discuss some partial extensions of the above work to Riesz gases.

DAVID RENFREW, Binghamton University
[Saturday December 2 / samedi 2 décembre, 9:30 – Imagination]
Eigenvalues of minors of random matrices and roots of derivatives of random polynomials

I will describe the limiting behavior of the eigenvalues of minors of large bi-unitarily random matrices and the roots of derivatives of polynomials with independent, random coefficients, by giving a convolution semi-group which relates the two processes together. This is joint work with Andrew Campbell and Sean O'Rourke.

AARON SMITH, uOttawa and TIMC
[Saturday December 2 / samedi 2 décembre, 10:00 – Imagination]
Kac's Walk on SO(n) and Related Chains

Kac's walks on the sphere and on the special orthogonal group, introduced in 1953 and 1970, have long histories in the statistical physics and computational statistics literatures. I will describe the history of these walks and present a method for estimating their mixing times in terms of the singular values of a related random matrix. Time permitting, I'll introduce some closely-related but more complicated problems in random matrix theory that may be of interest to this workshop's participants.

Viv(r)e les mathématiques

Org: Michèle Couderette (IRL CRM-CNRS ; UPEC-LDAR), **Eva Knoll** (UQAM), **Valériane Passaro** (UQAM) and/et **Fabienne Venant** (UQAM)

We are involved with mathematics on a daily basis in our work, but how do we live them ? Our individual experience has some bearing on our practice and vice versa. In this session participants will experiment in order to explore this relationship and its possible consequences for the classroom.

Nous nous préoccupons de mathématiques tous les jours dans notre travail, mais comment les vivons-nous ? Notre expérience individuelle a son effet sur notre pratique personnelle et vice versa. Dans cette session, nous expérimenterons pour explorer cette relation et ses conséquences possible pour la salle de classe.

Schedule/Horaire **Room/Salle: Grand Salon Opera A**

Saturday December 2 **samedi 2 décembre**

8:30 - 11:00 Eva Knoll (Université du Québec à Montréal), *Viv(r)e les mathématiques* (p. 180)

Abstract/Résumé

EVA KNOLL, Université du Québec à Montréal
[Saturday December 2 / samedi 2 décembre, 8:30 – Grand Salon Opera A]
Viv(r)e les mathématiques

Nous nous préoccupons de mathématiques tous les jours dans notre travail, mais comment les vivons-nous ? Notre expérience individuelle a son effet sur notre pratique personnelle et vice versa. Dans cette session, nous expérimenterons pour explorer cette relation et ses conséquences possible pour la salle de classe.

We are involved with mathematics on a daily basis in our work, but how do we live them ? Our individual experience has some bearing on our practice and vice versa. In this session participants will experiment in order to explore this relationship and its possible consequences for the classroom.

Wave Phenomena and Partial Differential Equations

Org: George Shaohua Chen (Cape Breton University), **Ming Mei** (McGill University & Champlain College St-Lambert) and/et **Chunhua Ou** (Memorial University)

This scientific session is aimed to bring together the leading experts as well as promising young researchers to present their recent results in wave phenomena for partial differential equations with applications in fluid dynamics and ecology. Key topics focus on the structure of traveling waves, shock waves, rarefaction waves, diffusion waves, and their asymptotic stability, etc. It also provides a premier interdisciplinary forum for senior and junior researchers to exchange their experiences in the study of partial differential equations. The talks will span from analysis through modeling and computation to applications of partial differential equations.

Schedule/Horaire **Room/Salle: UQAM - PK-7210**

Saturday December 2 **samedi 2 décembre**

8:00 - 8:30	Gantumur Tsogtgerel (McGill University), *Elliptic estimates for operators with rough coefficients* (p. 183)
8:30 - 9:00	Ming Mei (McGill University & Champlain College St-Lamberta), *Threshold convergence results for non-local time-delayed diffusion equations* (p. 182)
9:00 - 9:30	Xinwei Yu (University of Alberta), *Some new regularity criterions for the 3D incompressible Navier-Stokes equations* (p. 183)
9:30 - 10:00	Jose Palacios Armesto (University of Toronto), *Asymptotic Stability of peakons for the Novikov equation* (p. 181)
10:00 - 10:30	Gael Yomgne Diebou (University of Toronto), *Non-blow up at large times and stability of global solutions to nematic liquid crystal flow* (p. 182)
15:00 - 15:30	Elena Braverman (University of Calgary), *Trimming harvesting strategies to natural dispersal for spatially heterogeneous populations* (p. 181)
15:30 - 16:00	Yuanxi Yue (Memorial University of Newfoundland), *Traveling wavefronts to a model of precursor and differentiated cells* (p. 183)
16:00 - 16:30	Weiyang Li (Memorial University of Newfoundland), *Liouville-type Laws for $-\Delta_m u + \|\nabla u\|^q = f(u)$ in Exterior Domains of $\mathbb{R}^N$* (p. 182)
16:30 - 17:00	Holger Teismann (Acadia University), *Dispersion as an obstruction to the bilinear control of Schrödinger equations* (p. 182)
17:00 - 17:30	George Shaohua Chen (Cape Breton University), *Improved blowup time estimate for fourth-order damped wave equation with strain term at arbitrary positive initial energy* (p. 182)

Abstracts/Résumés

JOSE PALACIOS ARMESTO, University of Toronto
[Saturday December 2 / samedi 2 décembre, 9:30 – UQAM - PK-7210]
Asymptotic Stability of peakons for the Novikov equation

The Novikov equation is an integrable Camassa-Holm-type equation with a cubic nonlinearity. One of its most important features is the existence of peaked traveling waves. In this talk, we will prove the asymptotic stability of those peakon solutions, under $H^1(\mathbb{R})$-perturbations satisfying that their associated momentum density defines a non-negative Radon measure. In order to do that, we first prove a rigidity theorem, sometimes called Liouville theorem. The main novelty in our analysis, compared to that of the Camassa-Holm case, comes from the fact that the momentum is not a conserved quantity anymore. To overcome this problem, we introduce a new Lyapunov functional unrelated to the (non-conserved) momentum of the equation.

Wave Phenomena and Partial Differential Equations

ELENA BRAVERMAN, University of Calgary
[Saturday December 2 / samedi 2 décembre, 15:00 – UQAM - PK-7210]
Trimming harvesting strategies to natural dispersal for spatially heterogeneous populations

Defining a diffusion strategy as the tendency to have a distribution proportional to a certain positive prescribed function, once a diffusion coefficient grows infinitely, we explore the influence of harvesting policies on the competition outcome. The talk is focused on the interplay of heterogeneity, variable diffusion strategies and space-dependent populations management, either harvesting or management combining possible relocation, culling and stocking.

GEORGE SHAOHUA CHEN, Cape Breton University
[Saturday December 2 / samedi 2 décembre, 17:00 – UQAM - PK-7210]
Improved blowup time estimate for fourth-order damped wave equation with strain term at arbitrary positive initial energy

By proposing a new differential inequality, we improve the upper bound of the blowup time estimate for the nonlinear fourth-order damped wave equation with strain term at arbitrary positive initial energy. We also give two new initial conditions to expand the range of the initial data leading to the finite time blowup of solutions. We obtain a sharp result of finite time blowup for the special case of the new differential inequality. Some simulations exhibit and verify the main results.

GAEL YOMGNE DIEBOU, University of Toronto
[Saturday December 2 / samedi 2 décembre, 10:00 – UQAM - PK-7210]
Non-blow up at large times and stability of global solutions to nematic liquid crystal flow

The flow of nematic liquid crystals is modeled by a system coupling the incompressible non-homogeneous Navier-Stokes equations and the transported harmonic maps heat flow to $\mathbb{S}^2$. An almost optimal global well-posedness result was established by Wang [11'] for small initial velocity and orientation field in BMO^{-1} and BMO, respectively. In this talk, I will discuss the stability question for a priori global solutions. Large solutions are shown to be small at large times, a property which is inferred by the geometric condition. The role of this smallness property in the stability result will be highlighted.

WEIYANG LI, Memorial University of Newfoundland
[Saturday December 2 / samedi 2 décembre, 16:00 – UQAM - PK-7210]
Liouville-type Laws for $-\Delta_m u + |\nabla u|^q = f(u)$ in Exterior Domains of $\mathbb{R}^N$

In this talk, I will introduce the Liouville type theorems for the m-Laplacian equation with gradient term $-\Delta_m u+|\nabla u|^q = f(u)$ in exterior domains of $\mathbb{R}^N$. Here $q > m-1$ and the function f satisfies $f(s) > cs^p$ near zero where c is a positive constant. This is based on a joint work with Yuhua Sun and Jie Xiao.

MING MEI, Champlain College St.-Lambert
[Saturday December 2 / samedi 2 décembre, 8:30 – UQAM - PK-7210]
Threshold convergence results for nonlocal time-delayed diffusion equations

In this talk, we consider the asymptotic behavior for nonlocal dispersion Nicholson blowflies equation. By the method of Fourier transform, we first derive the decay estimates for the fundamental solutions with time-delay. Then, we show the threshold results with optimal convergence rates for the original solution to the constant equilibrium. The lower-higher frequency analysis plays a crucial role in the proof. This talk is based on a recent joint work with Rui Huang and Zhuangzhuang Wang published in J. Differential Equations (2023).

Wave Phenomena and Partial Differential Equations

HOLGER TEISMANN, Acadia University
[Saturday December 2 / samedi 2 décembre, 16:30 – UQAM - PK-7210]
Dispersion as an obstruction to the bilinear control of Schrödinger equations

The control of quantum systems is an area of intense theoretical and experimental study with significant potential ramifications for technology, of which quantum computing is only the most widely publicized one. The present paper is part of a project on identifying limitations to what can be accomplished by the application of classical fields, in particular whether control can be achieved in arbitrarily small time. The fundamental equation of quantum theory, the Schrödinger equation, is a dispersive PDE. The purpose of this talk is to demonstrate that dispersion can act as an obstacle to controllability that prevents a large class of quantum systems (defined by decay or integrability conditions of the potential) from being controllable in finite time. There is also a large class of systems that cannot not even be controlled in infinite time.

GANTUMUR TSOGTGEREL, McGill University
[Saturday December 2 / samedi 2 décembre, 8:00 – UQAM - PK-7210]
Elliptic estimates for operators with rough coefficients

In this talk, we will present a new elementary approach to establishing elliptic estimates for a class of operators with rough coefficients, in the Triebel-Lizorkin and Besov scales. This is is a joint work with Mike Holst (UCSD) and David Maxwell (UAF).

XINWEI YU, University of Alberta
[Saturday December 2 / samedi 2 décembre, 9:00 – UQAM - PK-7210]
Some new regularity criterions for the 3D incompressible Navier-Stokes equations

In this talk we discuss several regularity criterions for the 3D incompressible Navier-Stokes equations, including several new classes of Prodi-Serrin type criterions, as well as a new type of geometrical conditions on the super level set of the velocity magnitude that guarantees regularity. This is a summary of joint work in recent years with Prof. Chuong V. Tran of the University of St. Andrews, Scotland, and Mr. Benjamin Pineau of the University of Alberta (Now at UC Berkeley).

YUANXI YUE, Memorial University of Newfoundland
[Saturday December 2 / samedi 2 décembre, 15:30 – UQAM - PK-7210]
Traveling wavefronts to a model of precursor and differentiated cells

This talk presents a comprehensive analysis of the rich and complex propagation dynamics to a model of precursor and differentiated cells, with the appearance of non-isolated equilibria on a line in the phase space. We established the existence of traveling waves in the monostable monotone case by means of continuation argument via perturbation in a weighted functional space, by applying the abstract implicit function theorem. We provided necessary and sufficient conditions of the minimal wave speed selection and proved the existence of the transition (turning point) k^* for the minimal wave speed when the parameters λ and γ are fixed. Two explicit estimates about k^* were given. We investigated the decay rate of the minimal traveling wave as $z \to \infty$ in terms of the value of k. We further proved the existence of non-negative wavefronts in the monostable non-monotone case and found that the minimal wave speed is always linearly selected. Finally, in the bistable monotone case, the existence and uniqueness of bistable traveling waves were proved via constructing an auxiliary parabolic non-local equation.

AARMS-CMS Student Poster Session
Présentations par affiches des étudiants - AARMS-SMC

Abstracts/Résumés

KYLIAN AJAVON, Concordia University

Surrogate models for diffusion on graphs: a high-dimensional polynomial approach

Graphs are an essential mathematical tool used to model real-life complex systems such as social networks and transportation networks. Understanding diffusion processes on graphs is crucial for modelling phenomena such as the propagation of information within a network of individuals or the flux of goods and/or people through a transportation network. Accurately simulating these diffusion processes can be, in general, computationally demanding since it requires the solution of large systems of ordinary differential equations.

Motivated by this challenge, we propose to construct surrogate models able to approximate the state of a graph at a given time from the knowledge of the diffusivity parameters. Specifically, we consider recently introduced high-dimensional approximation methods based on sparse polynomial expansions, which are known to produce accurate, sample-efficient approximations when the function to be approximated has holomorphic regularity. Hence, to justify our methodology, we will theoretically show that solution maps arising from a certain class of parametric graph diffusion processes are indeed holomorphic. Then, we will numerically illustrate that it is possible to efficiently compute accurate sparse polynomial surrogate models from a few random samples, hence empirically showing the validity of our approach.

OSAMA BATAINEH, Univ. of Saskatchewan

Imprecise Probabilities for Cryptanalysis of Ciphertexts

In cryptography, secrecy of ciphertext decryption is important and crucial for protection against cipher cyber-attacks. In ciphertext decryption, the appropriate probabilistic model must be selected to measure on occurrences of ciphertext characters. In this poster, imprecise probabilities are used to reflect the differences in prior beliefs amongst cryptanalysts, on probabilities of occurrences of alphabetic characters in ciphertexts. They can be used to give larger margin for predicting the correct keywords for successful decryption of difficult ciphertexts. For each character, there will be lower and upper bound probabilistic estimates based on using Bayesian methods with sets of prior distributions. It is important to see how prior changes, based on imprecise probability models, can impact changes in posterior distributions of ciphertexts, and their decryptions. Furthermore, imprecise probabilities can establish for new understanding of concepts of "perfect secrecy", "redundancy" and "unicity distance" in ciphertext decryption procedures.

JERMEY CHIZEWER, University of Waterloo

Enumeration and Compact Encoding of AVL Trees

An AVL tree is a type of self-balancing binary search tree commonly used in computer science. From an enumerative perspective, an AVL tree is a rooted planar binary tree such that the heights of the left and right subtrees at any node differ by at most one. Because AVL trees are most easily recursively decomposed by height instead of by number of nodes, their enumeration is more difficult than other classes of recursively defined trees.

Motivated by a desire to derive the information-theoretic lower bound on the number of bits needed to encode an AVL tree, we develop a new method for the study of combinatorial classes whose generating functions satisfy certain functional equations and use this tool to derive the growth rate of AVL trees and related structures. We also describe a new encoding for AVL trees that uses less than one bit per node.

Joint work with Stephen Melczer, J. Ian Munro, and Ava Pun.

SAYANTAN ROY CHOWDHURY, University of Western Ontario

Essential dimension of symplectic vector bundles over a curve

Essential dimension of an algebraic object, introduced by J.Buhler and Z.Reichstein, is defined as the minimal number of algebraic variables needed to parameterize the object. The essential dimension of a moduli stack is defined as the the supremum of the essential dimension of objects it parameterizes. This number can be computed only in a handful of cases. In general, bounds are hard to obtain, however Dhillon, Hoffmann and Biswas obtained such an upper bound for vector bundles over a smooth projective curve.

In this poster, we generalise these results in the case of symplectic vector bundles. The essential dimension of a symplectic vector bundle can be broken into two terms, namely the transcendence degree of its field of moduli and the essential dimension of the bundle over its field of moduli. We show that the first part can be related to the essential dimension of hermitian modules over an algebra, while the second part can be bounded by the dimension of moduli stack of symplectic vector bundles equipped with nilpotent morphism of symplectic type. We prove that the latter object is smooth and hence its dimension can be computed by a Riemann-Roch formula.

DANIEL DALLAIRE, University of Ottawa

The Chromatic Category: A Connection Between Planar Graph Colouring And Representation Theory

The chromatic category is a diagrammatic monoidal category which encodes information about the colourings of planar graphs. Although it has a direct relation to graph theory in this way, it can also be constructed in a representation theoretic context yielding an interesting connection between the problem of colouring planar graphs (in particular, the four colour theorem) and representation theory. In this work I explore these connections and prove results about the chromatic category. One main result is that this category is isomorphic to a category of representations of quantum $\mathfrak{sl}_2$, which in the 4-colour case, tells us the category is equivalent to a category of representations of (non-quantum) $\mathfrak{sl}_2$. In addition to this, I give bases for the morphism spaces in the category, discuss the category's relation to the well-known Temperley-Lieb category, and show that it is pivotal (allowing for topological arguments on the morphisms). Lastly, I give different presentations of the category, all of which are isomorphic to the chromatic category.

SPENCER LOCKE AND HAYLEY MONSON, McMaster University

The Saturn Ring Defect for Two Colloidal Particles

The study of nematic liquid crystals and the defects that arise due to various energy configurations has been of great interest to both mathematicians and physicists alike. In particular, it has been shown in the physics literature that there are several varieties of line defects which can be studied using a plethora of mathematical and physical models. In their 2016 paper, Alama, Bronsard & Lamy showed, using the Landau-de Gennes model for liquid crystals in a particular regime, that for a single spherical colloid immersed within such a nematic material, a ring defect is formed when the particle is sufficiently small, called the 'Saturn ring defect'. They also showed that the defect is formed at the positions where there is an exchange of the dominant eigenvalues from the Q-tensor. This tensor is the solution to the Laplace equation with Dirichlet boundary conditions on the particle. In this poster presentation, we will summarize the mathematics behind the Saturn ring defect, and we will present our extended problem analyzing the ring defect(s) that may arise for two colloidal particles. We will describe how, in this case, changing the domain to bispherical coordinates allows us to obtain an analytic solution for the Q-tensor. We will conclude by demonstrating how we can use our series solution to explicitly and numerically map the structure of the defects in the planar region situated exactly halfway between the colloids. We will also pinpoint the locations of the dominant eigenvalues and find where they cross.

SARAH LUCKY, Lakehead University

Actions of certain finite groups on lattice ordered dimension groups

Following the classification via K-theory of AF C^*-algebras by Elliott, the complementary range of invariant problem was solved by Effros, Handelman, and Shen when they characterized those partially ordered abelian groups that arise as inductive limits of simplicial groups. Later work by Elliott and Su led to the question of when a group action on a dimension group arises as

an inductive limit of actions on simplicial groups. Work of Choi and Dean gave a partial answer in the case of $\mathbb{Z}_2$ actions. The present work extends their results to actions of more finite groups.

MARCO MIGNACCA, McGill University

Motion Detection Using Dynamic Mode Decomposition

Dynamic Mode Decomposition (DMD) is a numerical method that seeks to fit timeseries data to a linear dynamical system. In doing so, DMD decomposes dynamic data into spatially coherent modes that evolve in time according to exponential growth/decay or with a fixed frequency of oscillation. A key example of timeseries data that DMD has been applied to are videos, where one interprets the high-dimensional pixel space evolving through time as the video plays. In this work, we propose a simple, interpretable motion detection security system for video firmly rooted in DMD. Our method leverages the idea that there exists a correspondence between the evolution of important video features (encoded in the coherent spatial modes) and the eigenvalues of the matrix resulting from DMD. Precisely, our method applies DMD to windowed subsets of the video, which allows one to localize disturbances in the frames by observing the dominant timescales present in the modes. The effectiveness of the algorithm in detecting motion in the video is measured through an analysis based on receiver operating characteristic (ROC) curves. Performance of the motion detection algorithm is optimized for a given dataset of training videos based on k-fold cross-validation.

SINA MOHAMMAD-TEHERI, Concordia University

Greedy deep unfolding: New neural networks based on sparse recovery algorithms

In recent years, *algorithm unfolding* (or *unrolling*) has emerged as a promising methodology in various signal-processing applications, notably in biomedical imaging. It aims to combine the strengths of sparse recovery and deep learning by designing deep neural network architectures that implement the iterations of an iterative algorithm as network layers. Despite its success, unfolding *greedy* sparse recovery algorithms like Orthogonal Matching Pursuit (OMP) or Compressive Sampling Matching Pursuit (CoSaMP) has received little attention. The primary challenge is the non-differentiable nature of the argsort operator, a key component in greedy algorithms, which hinders gradient backpropagation during training.

To address this, our work introduces a novel approach, termed 'greedy deep unfolding'. We utilize *soft sorting* to approximate the argsort operator in a differentiable manner. Additionally, we reinterpret greedy algorithms through a projection-based lens and approximate the permutation matrices from argsort with stochastic matrices derived from soft sorting. Our numerical and theoretical analyses show that under certain conditions, the approximation error is minimal, and the performance of the approximated greedy algorithm closely matches the original. We then incorporate this approximate algorithm into a feedforward neural network's layers, integrating learnable *weight* parameters to connect to weighted sparse recovery. Our numerical results demonstrate that this network is trainable and can surpass the performance of the traditional approximate greedy algorithm in certain scenarios.

KATE NIMEGEERS, University of Victoria

Pseudoku: A Sudoku Adjacency Algebra and Fractional Completion Threshold

We develop a new 4-partite graph representation, G_P, for a partial Sudoku, P. In this representation, partite sets correspond to the rows, columns, boxes, and symbols of P. The edges represent unfulfilled conditions in P that are necessary for a completed Sudoku. For instance, if symbol 3 is missing from the first row in P, an edge is drawn between those vertices in G_P. We define a tile to be a 4-vertex subgraph of G_P corresponding to a valid placement of a symbol in P. We note that P can be completed if and only if its graph representation G_P has an edge-decomposition into tiles. We then relate the existence of a tile-decomposition to the existence of a solution to a specific linear system using an edge-tile inclusion matrix. Through an in-depth analysis of this matrix structure, we uncover a Sudoku adjacency algebra. This algebraic framework is constructed from a coherent configuration, comprised of equivalence relations among row-column, row-symbol, column-symbol, and box-symbol Sudoku conditions.

The result we present is a degree threshold for G_P that allows a fractional tile-decomposition, implying the existence of a fractional completion of P. The proof employs spectral decomposition, the properties of coherent configurations, and perturbation theory to estimate a generalized inverse for the matrix representation of a partial Sudoku puzzle in order to find a solution for the relaxed linear system. Improving on this result by finding a minimum degree threshold for an exact tile-decomposition is an interesting open question in this research area.

ERIC SUI, Carleton University (Math Enrichment Centre)

On Intersections of Hyperplanes Formed by n Points in Low-Dimensional Space

This research poster explores discrete geometry, a field laden with aspects of not only geometry, but also combinatorics. It focuses on the counting of intersections in various dimensions, with a focus on the second and the third. We are given n points in k dimensional space. We form hyperplanes ($k-1$ dimensional objects) which are determined by k of the n points. How many unique $k-2$ dimensional intersections of these hyperplanes exist ? In this poster, we solve a simple combinatorial geometry problem as a precursor. This problem is defined in 2-dimensions and it is also focused on the formation of objects from points. Then, we solve the 2 dimensional and 3 dimensional cases using purely combinatorial techniques and provide diagrams for each of these cases. Further exploration would entail how we can solve this problem in 4 or higher dimensions. Possible approaches could be an inductive process involving lifting the points or a similar combinatorial approach for higher dimensions.

SILAS VRIEND, McMaster University

The standard lens cluster in $\mathbb{R}^2$ uniquely minimizes relative perimeter

We present a new type of planar partitioning problem in which one minimizes perimeter among clusters with one domain of finite area and two of infinite area. This generalizes the classical setting where one minimizes perimeter among clusters with a fixed number of domains of finite prescribed area. The classical isoperimetric problems have led to the famous double and triple bubble conjectures, which have both been proven to hold in the Euclidean plane. We use the planar double bubble theorem to show that the lens cluster is the unique minimizer for the isoperimetric problem of partitioning the plane into three disjoint domains, one having unit area and the remaining two having infinite area. In addition to the result, we present a general framework and several conjectures for this new class of problems in geometric measure theory.

ARTHUR WESLEY, Dalhousie University

On Quantum Circuits Enacting the E8 Weyl Group

The circuit diagrams studied in computer science enjoy a rich mathematical theory. Starting from a finite set of primitive operators known as "gates", a circuit diagram is any operator obtained by composing a finite number of gates in sequence or in parallel. A special class of circuit diagrams are the classical reversible circuits, in which gates are invertible matrices over $\mathbb{Z}_2$. It was shown by Toffoli in 1980 that every classical reversible circuit is constructible from a single primitive known as the Toffoli gate, given sufficiently many ancillas (i.e., working memory). Later, Feynman generalized classical reversible circuits to quantum mechanical systems in which invertible matrices are replaced by unitary matrices. Since unitary matrices are uncountable, there does not exist an exact universal gate set for quantum computation. However, given both the Toffoli gate and Hadamard gate, all unitary operators can be simulated.

In this poster, we describe ongoing work to obtain a minimal presentation for the group G of 3-qubit ancilla-free Toffoli+K circuits (where K is the two-fold tense of a Hadamard gate). From prior results in sphere packings, it follows that G is isomorphic to the E8 Weyl group. We start from the Coxeter presentation of this Weyl group and obtain a circuit presentation using a semantic variation of Tietze transformations. We use commutativity relations to prove generator minimality and implement a proof-assistant to validate each semantic transformation. Directions for future work, such as minimizing the set of relations and generalizing to the 3-qubit ancilla-free Toffoli+K circuits, are outlined.

AARMS-CMS Student Poster Session
Présentations par affiches des étudiants - AARMS-SMC

WILLIAM ZHANG, Concordia University
Broadcasting in NetworkX

Broadcasting is an information disseminating problem in a connected network of transmitting a message from an originator vertex to all other vertices as quickly as possible. It is well known that finding the broadcast time for any random vertex in an arbitrary graph is NP-complete. However, it has been proven that this problem can be solved in polynomial time for a certain class of graphs. The dissemination process is as follows ; the originator begins by placing a series of calls along the communication lines of the network. Every time the informed nodes help the originator in distributing the message. Every call is assumed to take place in discrete units of time. The broadcasting must be completed as quickly as possible subject to some constraints. This talk will demonstrate implementations of a broadcasting algorithm using the open-source graph library NetworkX. In addition, other related topics such as broadcast graphs and the design of efficient networks will be covered.

SICHENG ZHAO, Queen's University
Disease Spread on Networks using Percolation Methods and Edge-Based Modeling

Bond percolation methods can be used to model disease transmission on complex networks and accommodate social heterogeneity while keeping tractability. Here we review the seminal works on this field by Newman (2002, 2003, 2010), and Miller, Slim & Volz (2011) and present a more clear and systematic discussion about the theoretically background, assumptions, derivation and development of the percolation method. We also present a new R package based on these papers that take epidemic and network parameters as input and generates estimates of the epidemic trajectory and final size. This allows us to investigate the interaction between different community structures and disease control strategies, leading to interesting new research directions.

Canadian Journal of Mathematics

Canadian Journal of Mathematics (CJM) publishes original, high-quality research papers in all branches of mathematics. The Journal is a flagship publication of the Canadian Mathematical Society and has been published continuously since 1949. New research papers are published continuously online and collated into print issues six times each year.

To be submitted to the Journal, papers should be at least 18 pages long and may be written in English or in French. Shorter papers should be submitted to the *Canadian Mathematical Bulletin*.

Le Journal canadien de mathématiques (JCM) publie des articles de recherche innovants de grande qualité dans toutes les branches des mathématiques. Publication phare de la Société mathématique du Canada, il est publié en continu depuis 1949. En ligne, la revue propose constamment de nouveaux articles de recherche, puis les réunit dans des numéros imprimés six fois par année.

Les textes présentés au JCM doivent compter au moins 18 pages et être rédigés en anglais ou en français. C'est le *Bulletin canadien de mathématiques* qui reçoit les articles plus courts.

Find out more: cambridge.org/CJM

Accepts Open Access

Useful Links

DISCOVER
OUR AIMS & SCOPE

VIEW
THE EDITORIAL BOARD

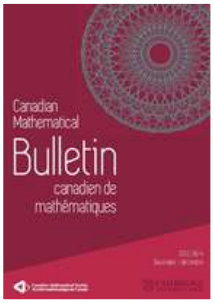
EXPLORE
OUR INSTRUCTIONS FOR AUTHORS

ACTIVATE
STAY UPDATED WITH THE LATEST CONTENT

JOIN THE CONVERSATION

CAMBRIDGE UNIVERSITY PRESS

Canadian Mathematical Bulletin



Canadian Mathematical Bulletin was established in 1958 to publish original, high-quality research papers in all branches of mathematics and to accommodate the growing demand for shorter research papers. The *Bulletin* is a companion publication to the Canadian Journal of Mathematics that publishes longer papers. New research papers are published continuously online and collated into print issues four times each year.

To be submitted to the *Bulletin*, papers should be at most 18 pages long and may be written in English or in French. Longer papers should be submitted to the *Canadian Journal of Mathematics*.

Fondé en 1958, le *Bulletin canadien de mathématiques* (BCM) publie des articles d'avant-garde et de grande qualité dans toutes les branches des mathématiques, de même que pour répondre à la demande croissante d'articles scientifiques plus brefs. Le BCM se veut une publication complémentaire au Journal canadien de mathématiques, qui publie de longs articles. En ligne, il propose constamment de nouveaux articles de recherche, puis les réunit dans des numéros imprimés quatre fois par année.

Les textes présentés au BCM doivent compter au plus 18 pages et être rédigés en anglais ou en français. C'est le *Journal canadien de mathématiques* qui reçoit les articles plus longs.

Find out more: cambridge.org/BCM

Accepts open access

Useful Links

DISCOVER
OUR AIMS & SCOPE

VIEW
THE EDITORIAL BOARD

EXPLORE
OUR INSTRUCTIONS FOR AUTHORS

ACTIVATE
STAY UPDATED WITH THE LATEST CONTENT

JOIN THE CONVERSATION

CAMBRIDGE UNIVERSITY PRESS

Canadian Mathematical Society
Société mathématique du Canada

Call for nominations
Appel de mises en candidature

2024 CMS

Blair Spearman Doctoral Prize
Prix de doctorat Blair Spearman

de la SMC 2024

In recognition of an outstanding performance by a doctoral student who graduated from a Canadian university in the preceding year.

En reconnaissance d'une performance exceptionnelle d'un(e) doctorant(e) diplômé(e) d'une université canadienne au cours de l'année précédente.

Submit all documentation to docprize@cms.math.ca
no later than January 31, 2024

Soumettez tous les documents à prixdoc@smc.math.ca
au plus tard le 31 janvier 2024

Canadian Mathematical Society
Société mathématique du Canada

Call for nominations
Appel de mises en candidature

2024 CMS

Graham Wright Prize
Prix Graham Wright

de la SMC 2024

In recognition of an individual who has made sustained and significant contributions to the Canadian mathematical community and, in particular, to the Canadian Mathematical Society.

En reconnaissance d'une personne ayant apporté une contribution soutenue et significative à la communauté mathématique canadienne et, en particulier, à la Société mathématique du Canada.

Submit all documentation to gwaward@cms.math.ca
no later than March 31, 2024

Soumettez tous les documents à prixgw@smc.math.ca
au plus tard le 31 mars 2024

Canadian Mathematical Society
Société mathématique du Canada

Call for nominations
Appel de mises en candidature

2024

CMS Fellows
Fellows de la SMC

2024

In recognition of CMS members who have made excellent contributions to mathematical research, teaching, or exposition, as well as distinguished themselves in service to Canada's mathematical community.

En reconnaissance des membres de la SMC qui ont apporté d'excellente contributions à la recherche, à l'enseignement ou à l'exposition en mathématiques, et qui se sont distingués par leurs services à la communauté mathématique du Canada.

Submit all documentation to awards-prizes@cms.math.ca
no later than March 31, 2024

Soumettez tous les documents à awards-prizes@cms.math.ca
au plus tard le 31 mars 2024

Canadian Mathematical Society
Société mathématique du Canada

Call for nominations
Appel de mises en candidature

2024 CMS

Adrien Pouliot Prize
Prix Adrien Pouliot

de la SMC 2024

In recognition of an individual or a team of individuals who have made significant and sustained contributions to mathematics education in Canada.

En reconnaissance d'une personne ou d'une équipe de personnes ayant apporté une contribution significative et continue à la didactique des mathématiques au Canada.

Submit all documentation to apaward@cms.math.ca
no later than April 30, 2024

Soumettez tous les documents à prixap@smc.math.ca
au plus tard le 30 avril 2024

Canadian Mathematical Society
Société mathématique du Canada

2024 CMS Summer Meeting | Saskatoon, Saskatchewan

Call for Sessions

The Canadian Mathematical Society (CMS) welcomes and invites session proposals and mini-course proposals for the 2024 CMS Summer Meeting in Saskatoon from May 31 to June 3, 2024. In accordance with the CMS mandate to propose conferences that are accessible and welcoming to all groups, diversity amongst organizers and speakers is strongly encouraged. Diversity includes topics of interest, career stages, geographic location, and demographics.

CALL FOR SESSIONS:

Proposals should include:
(1) Names, affiliations, and contact information for all session co-organizers. Early career researchers are encouraged to propose sessions.
(2) A title and brief description of the topic and purpose of the session. This can include an overview of the subject.
(3) The total number of expected talks, with a list of possible speakers and/or papers in the theme. Sessions should strive to respect the above CMS policy of accessibility and diversity.

Open Call for Abstracts: The CMS will continue the open abstract submission process that was recently introduced to support session organizers in their important work and in their efforts towards inclusivity and diversity.

The CMS kindly asks session organizers to consider all eligible abstract submissions for their session, as up to 30 speakers per session can be accommodated.

The scientific sessions will take place from May 31 - June 3, 2024.

Deadline: Proposals should be submitted by ***Wednesday, January 31, 2024*** to the Scientific Directors and the CMS Office should be cc'ed. There will be a second deadline of ***March 29, 2024***, but earlier submissions will be considered first. Their contact information is as follows:

Elana Kalashnikov: e2kalash@uwaterloo.ca
Steven Rayan: rayan@math.usask.ca
Jacek Szmigielski: szmigiel@math.usask.ca

Sarah Watson: meetings@cms.math.ca

Canadian Mathematical Society
Société mathématique du Canada

Réunion d'été 2024 de la SMC | Saskatoon, Saskatchewan

Appel de Sessions

La Société mathématique du Canada (SMC) sollicite des propositions de sessions scientifiques et de mini-cours pour sa réunion d'été 2024, qui se tiendra à Saskatoon du 31 mai au 3 juin. Conformément à son mandat de proposer des congrès accessibles et accueillants pour tous les groupes, la SMC encourage fortement la diversité parmi les personnes qui organisent ses réunions ou y donnent des conférences. La diversité s'applique aux domaines d'intérêt, à l'étape de la carrière, à l'emplacement géographique et aux caractéristiques démographiques.

APPEL DE SESSIONS :

Les propositions doivent inclure :
1) Les noms, affiliations et coordonnées de tous les co-organisateurs de sessions. On encourage les chercheurs en début de carrière à proposer des sessions.
2) Un titre et une brève description du sujet et de l'objectif de la session; peut aussi comprendre un aperçu du sujet.
3) Le nombre de conférenciers attendus, avec une liste de communications et/ou de conférenciers potentiels pour le thème. Dans la mesure du possible, les sessions devraient respecter la politique d'accessibilité et d'accueil de la SMC.

Appel ouvert de résumés : La SMC met en place un appel ouvert de résumés pour aider les organisateurs de sessions dans leur important travail et dans leurs efforts d'inclusion et de diversité.

La SMC vous prie de considérer les soumissions de tout candidat admissible. Nous jusqu'à 30 conférenciers par session seront accommodés.

Les sessions scientifiques se dérouleront du 31 mai au 3 juin 2024.

La date limite pour présenter une proposition de session ou de mini-cours est le ***merceredi 31 janvier 2024.*** Une deuxième date limite sera fixée au ***29 mars 2024***, mais les demandes antérieures seront examinées en premier lieu. Toute demande doit être envoyée aux Directeurs scientifiques et le bureau de la SMC doit y être copié. Vous trouverez ci-dessous leurs coordonnées :

Elana Kalashnikov : e2kalash@uwaterloo.ca
Steven Rayan : rayan@math.usask.ca
Jacek Szmigielski : szmigiel@math.usask.ca

Sarah Watson: meetings@cms.math.ca

Call for University Hosts : Summer 2026 & Summer 2027

The Canadian Mathematical Society (CMS) welcomes and invites hosts proposals from Canadian Universities for the 2026 and 2027 CMS Summer Meetings. All applications are warmly encouraged, but please note that priority will be given to the East Coast for the Summer 2026 meeting.

CMS will provide all logistical support and contract negotiation with local venues. CMS is looking for Canadian Universities that are willing and able to showcase their department and University to students and faculties from across Canada. It is asked that proposals include the following information:

1.Location

- How would people get from the airport to the venue?
- What are the reasons your city may be of interest to Canadian mathematicians?

2. Site

- Describe the University where the meeting would be held.
  - Which building would the meeting be in and how many rooms are available for meeting sessions and plenaries? What technological support is available in session rooms?
  - Will the rooms be available during the proposed dates?

3. Lodging

- Is your university able to offer any residence lodging during the conference dates? CMS will take care of contracting and negotiating with hotels.

4. Host University

- Please describe your institution and department briefly.
  - What funding support will the Host University have for the CMS Meeting?
  - Is the University available for regular calls and updates on the meeting's progress?
  - Can the Host University commit and provide at least one scientific director for the meeting? What level of participation do you think there might be from academics at your institution?

The CMS Summer Meetings typically run from Friday to Monday on the first weekend in June, but we are open to other possibilities. Summer Meetings typically have 250-350 registrants. Please admit your submissions to Sarah Watson (meetings@cms.math.ca).

Appel de candidatures pour des universités hôtes : Été 2026 & Été 2027

La Société mathématique du Canada (SMC) invite les universités canadiennes à se proposer comme hôtes pour les réunions d'été 2026 et 2027 de la SMC. Toutes les demandes sont vivement encouragées, mais veuillez noter que la priorité sera accordée à la côte Est pour la réunion de l'été 2026.

La SMC assurera tout le soutien logistique et la négociation des contrats avec les établissements locaux. La SMC recherche des universités canadiennes désireuses et capables de présenter leur département et leur université aux étudiants et aux facultés de tout le Canada. Les propositions doivent contenir les informations suivantes :

1.Emplacement

- Comment les gens se rendraient-ils de l'aéroport au lieu de la conférence ?
- Pour quelles raisons votre ville pourrait-elle intéresser les mathématiciens canadiens ?

2. Site

- Décrivez l'université où se tiendrait la réunion.
  - Dans quel bâtiment se déroulerait la réunion et combien de salles sont disponibles pour les séances et les plénières ? Quel est le soutien technologique disponible dans les salles de séance ?
  - Les salles seront-elles disponibles aux dates proposées ?

3. Hébergement

- Votre université est-elle en mesure d'offrir un hébergement en résidence pendant les dates de la conférence ? La SMC s'occupera des contrats et des négociations avec les hôtels.

4. Université hôte

- Veuillez décrire brièvement votre institution et votre département.
  - Quel soutien financier l'université hôte aura-t-elle pour la réunion de la SMC ?
  - L'université est-elle disponible pour des appels réguliers et des mises à jour sur les progrès de la réunion ?
  - L'université d'accueil peut-elle s'engager à fournir au moins un directeur scientifique pour la réunion ? Quel niveau de participation pensez-vous qu'il pourrait y avoir de la part des universitaires de votre institution ?

Les réunions d'été de la SMC se déroulent généralement du vendredi au lundi, le premier week-end de juin, mais nous sommes ouverts à d'autres possibilités. Les réunions d'été comptent généralement entre 250 et 350 participants. Veuillez envoyer vos propositions à Sarah Watson (meetings@cms.math.ca).

Canadian Mathematical Society
Société mathématique du Canada

See you next year

SAVE THE DATE

RÉSERVEZ LA DATE

À l'année prochaine

2024 CMS Summer Meeting
Réunion d'été 2024 de la SMC

May 31 to June 3 | Du 31 mai au 3 juin

SASKATOON, SK

See you next year

SAVE THE DATE

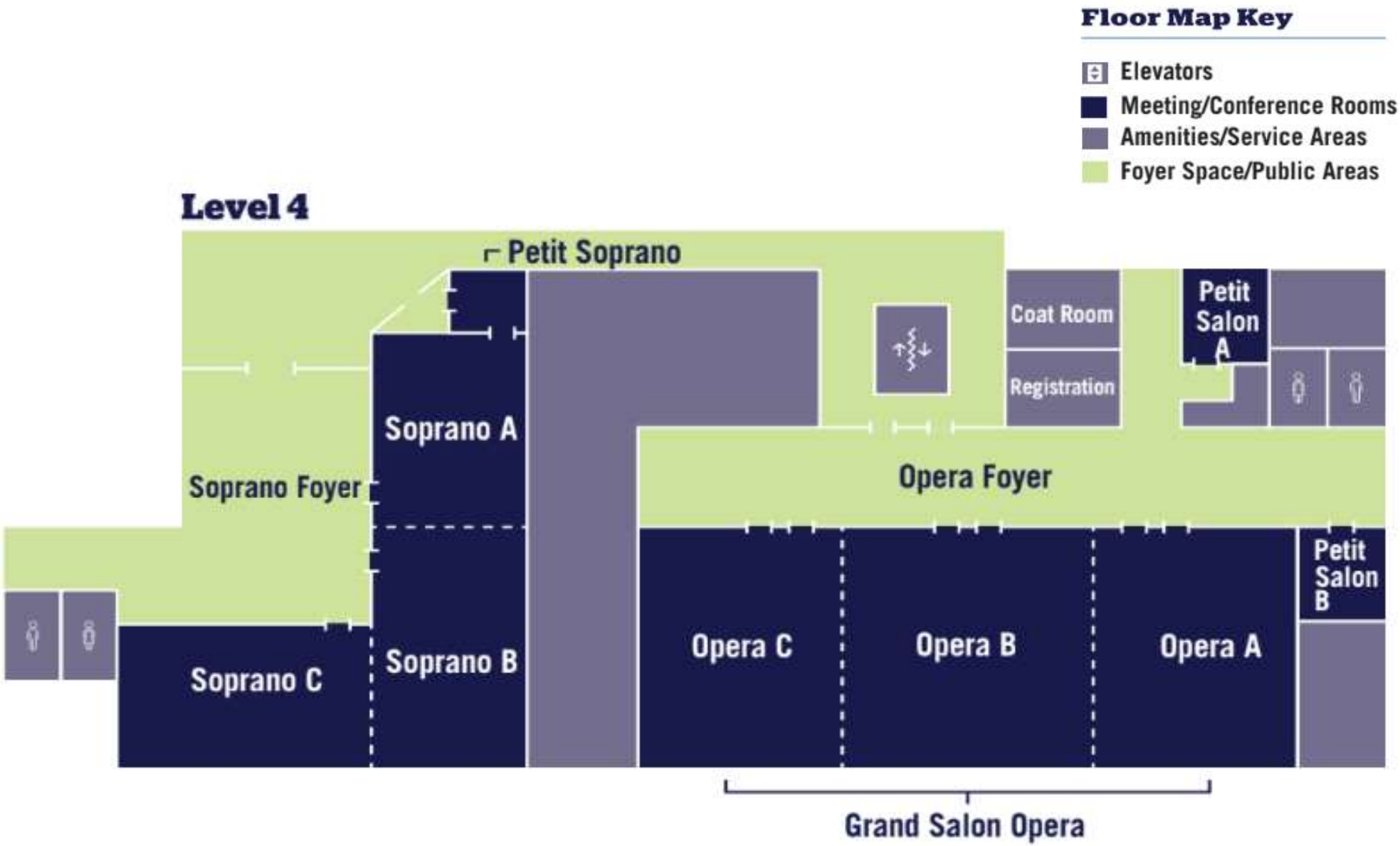
RÉSERVEZ LA DATE

À l'année prochaine

2024 CMS Winter Meeting
Réunion d'hiver 2024 de la SMC

Nov 29 to Dec 2 | Du 29 nov au 2 déc

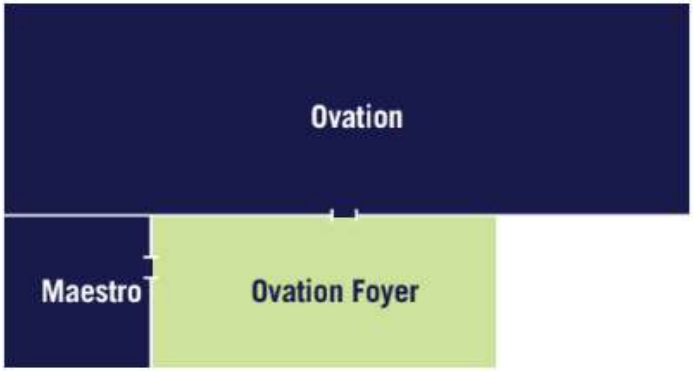
RICHMOND, BC

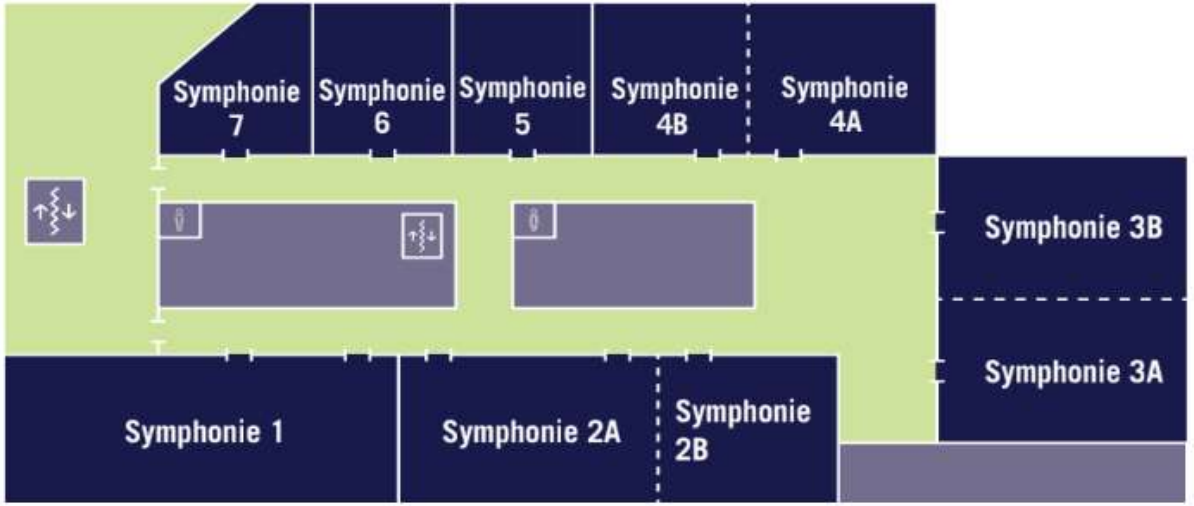

Floor Map Key
Elevators
Meeting/Conference Rooms
Amenities/Service Areas
Foyer Space/Public Areas
Level 4
Petit Soprano
Coat Room
Registration
Petit Salon A
Soprano A
Soprano Foyer
Opera Foyer
Petit Salon B
Soprano C
Soprano B
Opera C
Opera B
Opera A
Grand Salon Opera

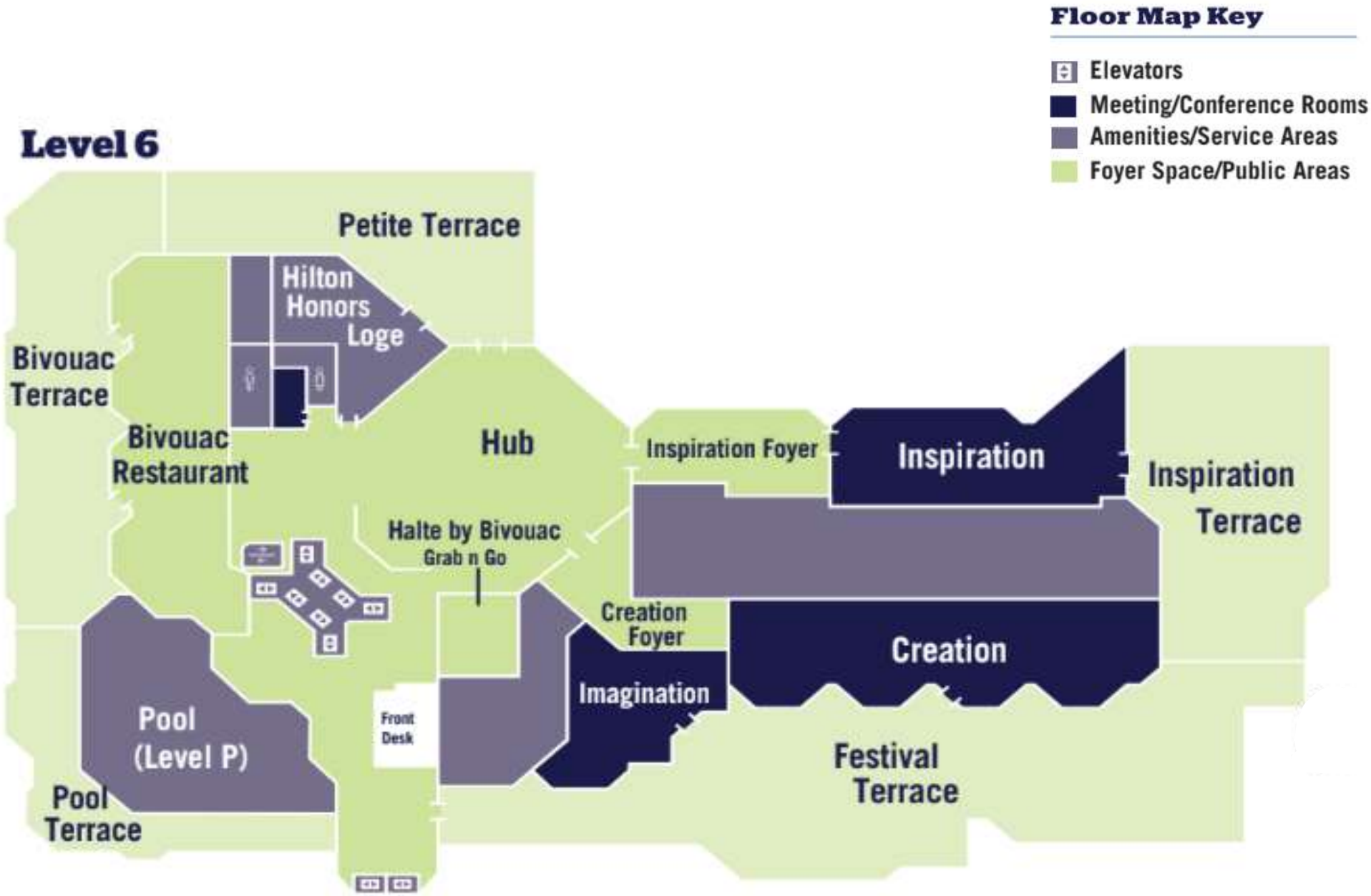
Floor Map Key

- Elevators
- Meeting/Conference Rooms
- Amenities/Service Areas
- Foyer Space/Public Areas

Level 5






Floor Map Key
Elevators
Meeting/Conference Rooms
Amenities/Service Areas
Foyer Space/Public Areas
Level 6
Petite Terrace
Hilton Honors Loge
Bivouac Terrace
Bivouac Restaurant
Hub
Inspiration Foyer
Inspiration
Inspiration Terrace
Halte by Bivouac Grab n Go
Creation Foyer
Creation
Imagination
Front Desk
Pool (Level P)
Pool Terrace
Festival Terrace