Canadian Mathematical Society
Société mathématique du Canada

2023 CMS SUMMER MEETING
PROGRAMME
RÉUNION D'ÉTÉ SMC 2023

Canadian Mathematical Society
Société mathématique du Canada

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CMS Summer Meeting 2023 | Réunion d'été de la SMC 2023
University of Ottawa
Ottawa, Ontario

Friday | Vendredi June 2 juin	Saturday | Samedi June 3 juin	Sunday | Dimanche June 4 juin	Monday | Lundi June 5 juin
8:00 - 19:30 - Registration | Inscription STEM 117	7:30 - 18:00 - Registration | Inscription 8:30 - 16:30 - Poster Session Affiches 10:00 - 16:30 - Exhibits | Expositions STEM 117	7:30 - 18:00 - Registration | Inscription 8:30 - 16:30 - Poster Session Affiches 10:00 - 16:30 - Exhibits | Expositions STEM 117	7:30 - 18:00 - Registration | Inscription STEM 117
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 STEM Atrium	10:30 – 11:00 Break | Pause STEM Atrium	10:30 – 11:00 Break | Pause STEM Atrium
12:30 – 16:30 CMS Board of Directors Meeting | Réunion du Conseil d'administration SMC STEM 101 13:00 - 16:00 CMS Mini-Courses | Mini-cours de la SMC CMS Professional Development | Série de développement professionnel de la SMC	11:00 – 12:00 Emmy Murphy Plenary Lecture Conférence plénière STEM 224	11:00 – 12:00 Deborah Hughes Hallett Education Lecture Conférence sur l'éducation STEM 224	11:00 – 12:00 Jude Kong Plenary Lecture Conférence plénière STEM 224
	12:00 – 13:30 Break | Pause CMS Women in Math Mentorship Lunch	12:00 – 13:30 Break | Pause 12:15 - 13:15 Annual General Meeting	12:00 – 13:30 Break | Pause 12:15 - 13:30 Perspectives on Canadian science: a fireside chat
	13:30 – 14:30 Kumar Murty Jeffrey-Williams Prize Lecture Conférence de prix Jeffrey-Williams STEM 224	13:30 – 14:30 Johanna G. Nešlehová Krieger-Nelson Prize Lecture Conférence de prix Krieger-Nelson STEM 224	13:30 – 14:30 Fok-Shuen Leung Public Excellence in Teaching Prize Lecture Conférence de prix en enseignement ouvert au publique STEM 224
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18:00 – 19:30 Welcome Reception & Book Swap| Réception de bienvenue et échange de livre STEM Atrium & 117	19:00 – 21:00 Student Social | Soirée étudiante	19:00 – 22:30 Reception and Awards Banquet Réception et Banquet de prix (@Lagos, Dows Lake Pavilion)	

SATURDAY

#	ROOM	SATURDAY AM	SATURDAY PM
1	LMX 243	Arithmetic aspects of automorphic forms	
2	STEM 364		Biostatistics
3	CRXC 407	Combined Games Session	
4	LMX 407	Computational Aspects in Low-Dimensional Topology and Contact Geometry	
5	LMX 219	C*-algebras and Applications	
6	STEM 664		Design theory and graph decomposition
7	STEM 201	Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics	
8	LMX 241	Geometry for Partial Differential Equations	
9	LMX 220	Hopf Algebras and Related Topics	
10	LMX 240	Interaction Of Discrete and Convex Geometry with Analysis and Combinatorics	
11	LMX 242	Mathematical Modelling in Public Health	
12	LMX 451	Mathematics of Machine Learning	
13	CRXC 408	Matrices and Operators	
14	LMX 218	Noncommutative Algebra and Noncommutative Geometry	
15	LMX 254	Noncommutative Geometry and Mathematical Physics	
16	LMX 418	Numerical Methods for Partial Differential Equations	
17	LMX 390	Optimal Transport in Natural and Data Sciences	
18	STEM 464	Quadratic forms and Linear algebraic groups	
19	LMX 360	Quantum Information Theory	
20	LMX 405	Recent Advances in Mathematical Finance	
21	CRX C309	Set Theory and It's applications	
22	STEM 224	Skills Coaching in Mathematics Classrooms	
23	LMX 221	Special Session in Number Theory in Celebration of the 70th Birthday of Ram Murty	
24	CRX C309	Student Research Talks	
25	STEM 207		Women in Math Luncheon

SUNDAY

#	ROOM	SUNDAY AM	SUNDAY PM
1	LMX 243	Arithmetic aspects of automorphic forms	
2	STEM 364		Biostatistics
3	CRXC 407	Combined Games Session	Applying Mathematics to Operations Research and Real Life Problems
4	LMX 407	Computational Aspects in Low-Dimensional Topology and Contact Geometry	
5	LMX 219	C*-algebras and Applications	
6	STEM 664	Design theory and graph decomposition	p-adic groups and representations in the Langlands program
7	CRX C309	Early Career Research in Number Theory	
8	STEM 201	Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics	
9	LMX 241	Geometry for Partial Differential Equations	
10	LMX 390	Group Symmetries and Equivariance	
11	LMX 220	Hopf Algebras and Related Topics	
12	LMX 240	Interaction Of Discrete and Convex Geometry with Analysis and Combinatorics	
13	LMX 418	Interplay between analysis and Convextivity	
14	LMX 242	Mathematical Modelling of Ecological, Evolutionary and Infectious Disease Dynamics	
15	LMX 451	Mathematics of Machine Learning	
16	LMX 218	Noncommutative Algebra and Noncommutative Geometry	
17	LMX 254	Noncommutative Geometry and Mathematical Physics	
18	STEM 464	Quadratic forms and Linear algebraic groups	Equivariant Schubert calculus and beyond
19	LMX 360	Quantum Information Theory	
20	LMX 405	Recent Advances in Mathematical Finance	
21	CRC 308	Set Theory and It's applications	
22	STEM 224	Sophisticated Stories from the High School Classroom	
23	CRXC 240	Special Session in Number Theory in Celebration of the 70th Birthday of Ram Murty	
24	CRXC 408	Theory and Applications of Finite Fields	
25	STEM 207	Women in Math Luncheon	

MONDAY

#	ROOM	MONDAY AM	MONDAY PM
1	STEM 224	A Conversation on Implementations of IBL Techniques (Panel)	
2	CRXC407	Advances in AI/ML and Mathematics for Economics Modelling and Analysis	
3	CRX C309	Early Career Research in Number Theory	
4	STEM 464	Equivariant Schubert calculus and beyond	
5	LMX 390	Group Symmetries and Equivariance	
6	LMX 220	Hopf Algebras and Related Topics	
7	LMX 418	Interplay between analysis and Convextivity	
8	STEM 201	Maplesoft Tutorial and Luncheon	
9	LMX 242	Mathematical Modelling of Ecological, Evolutionary and Infectious Disease Dynamics	
10	STEM 664	P-adic Groups and Representations in the Langlands program	

PRESIDENT'S WELCOME LETTER

On behalf of the Canadian Mathematical Society, it is my pleasure to welcome you to Ottawa and the 2023 CMS Summer Meeting. This conference promises to provide many opportunities to gather together and engage in mathematical discussion. The scientific organising committee, led by directors Monica Nevins (University of Ottawa) and Aaron Tikuisis (University of Ottawa), have built a programme of 35 sessions and 3 mini-courses on a diverse collection of topics spanning mathematics education, applied mathematics, pure mathematics, as well as probability and statistics.

The conference programme begins with a public lecture on Friday June 2nd by John Urschel (Harvard). Also featured are three plenary lectures by Deborah Hughes Hallett (Harvard Kennedy School and University of Arizona), Emmy Murphy (Princeton), and Jude Dzevela Kong (York). Other special events during the conference include a student poster session on Saturday June 3rd, a Women in Mathematics Mentorship luncheon also on the 3rd, and several prize lectures.

At the banquet scheduled for Sunday evening we will celebrate and recognise Johanna G. Nešlehová (McGill) as a winner of the Krieger-Nelson Prize, Kumar Murty (Fields) as a winner of the Jeffery-Williams Prize, and Fok-Shuen Leung (UBC) as a winner of the CMS Excellence in Teaching Prize. 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 organisers and speakers, volunteers 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: AARMS, CRM, Fields, PIMS, RBC, and Maplesoft. RBC's generosity in particular has provided registration subsidies to several students who belong to under-represented and equity-seeking groups.

To the conference participants, I hope that you have a positive and productive meeting, and that you enjoy coming together to discuss mathematics in person once again. Please take a moment to talk to the CMS staff at the registration desk, whose diligence during the disruptions of the past few years has been remarkable. They will appreciate your personal thanks, and if you are not currently a CMS member they will be pleased to tell you about the Society's many activities above and beyond hosting conferences.

Welcome

David Pike

LETTRE DE BIENVENUE DU PRÉSIDENT

Au nom de la Société mathématique du Canada, j'ai le plaisir de vous souhaiter la bienvenue à Ottawa et à la Réunion d'été de la SMC 2023. Cette conférence promet d'offrir de nombreuses occasions de se réunir et de participer à des discussions mathématiques. Le comité d'organisation scientifique, dirigé par les directeurs Monica Nevins (Université d'Ottawa) and Aaron Tikuisis (Université of d'Ottawa), a construit un programme de 35 sessions et 3 mini-cours sur une collection variée de sujets couvrant l'enseignement des mathématiques, les mathématiques appliquées, les mathématiques pures, ainsi que les probabilités et les statistiques.

Le programme de la conférence commence par une conférence publique le vendredi 2 juin par John Urschel (Harvard). Trois conférences plénières seront également données par Deborah Hughes Hallett (Harvard Kennedy School and University of Arizona), Emmy Murphy (Princeton), and Jude Dzevela Kong (York). Parmi les autres événements spéciaux de la conférence, citons une session d'affiches pour les étudiants le samedi 3 juin, un déjeuner de mentorat des femmes en mathématiques également le 3, et plusieurs conférences de prix.

Lors du banquet prévu le dimanche soir, nous célébrerons et reconnaîtrons Johanna G. Nešlehová (McGill) comme lauréat du prix Krieger-Nelson, Kumar Murty (Fields) comme lauréat du prix Jeffery-Williams, et Fok-Shuen Leung (UBC) comme lauréat du prix d'Excellence en éducation de la SMC. Les lauréats de la session d'affiches des étudiants seront également honorés au cours 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 et le personnel de la SMC, à qui j'adresse tous mes remerciements. Au nom de la Société, je souhaite également exprimer notre gratitude aux commanditaires de la réunion : AARMS, CRM, Fields, PIMS, RBC, et Maplesoft. La générosité de RBC, en particulier, a permis de subventionner l'inscription de plusieurs étudiants appartenant à des groupes sous-représentés et en quête d'équité.

Aux participants à la conférence, j'espère que votre réunion sera positive et productive, et que vous serez heureux de vous retrouver une fois de plus pour discuter des mathématiques en personne. Veuillez prendre un moment pour parler au personnel de la SMC au bureau d'inscription, dont la diligence pendant les perturbations de ces dernières années a été remarquable. Ils apprécieront vos remerciements personnels, et si vous n'êtes pas actuellement membre de la SMC, ils seront heureux de vous parler des nombreuses activités de la Société au-delà de l'organisation de conférences.

Bienvenue

David Pike

SCIENTIFIC DIRECTOR'S WELCOME LETTER

Monica Nevins

Aaron Tikuisis

Welcome to the 2023 Canadian Mathematical Society Summer meeting! Our department was excited to seize the opportunity to host the summer meeting, and to show off our new home in the STEM building (for those who might have known our old "quaint" digs)... back in 2020. Oh, well. It became a virtual meeting, in Summer 2021... but now we are here, and delighted to finally welcome you to our campus in 2023!

Our line-up for this meeting includes a variety of events, both new and old, with activities aimed to engage everyone in our mathematical community --- from students to professors, from teaching-stream faculty to industry-based researchers --- and we hope you have a chance to take part (and to tell us what you think). Friday's pre-meeting schedule includes workshops and mini-courses; Saturday night features the ever-popular student social; and on Sunday we'll head to beautiful Dow's Lake to enjoy the banquet out on the water. Don't forget our first-ever book swap, and be on the look-out for great deals on CMS books and merch!

Check out our lunchtime activities: a mentoring lunch for female-identifying mathematicians; the Annual General Meeting for CMS members; and a novel "fireside chat" with NSERC President Alejandro Adem and Chief Science Advisor Mona Nemer, moderated by Douglas Farenick, an intimate opportunity to ask your questions about the future of mathematics in Canada.

We're very excited to share an excellent line-up of plenary speakers with you, representing a full and exciting range of mathematics. John Urschel (Harvard) sets the tone with an opening public lecture "The Magic of Determinants" on Friday before the opening reception. Saturday's lectures are focused on topics in pure mathematics, with the plenary lecture "Flexibility in contact and symplectic geometry" by Emmy Murphy (Princeton) in the morning and the Jefferey-Williams prize lecture "ζ(3), log2, and π" by Kumar Murty (Toronto) in the afternoon.

On Sunday morning, Deborah Hughes Hallett (Harvard Kennedy School and University of Arizona) will deliver the Education plenary "Harnessing the Curiosity of Today's Students—Tomorrow's Decision Makers" while in the afternoon Johanna G. Nešlehová (McGill) delivers her Krieger-Nelson Prize lecture "Extreme or not extreme: the intricacies and challenges of rare event modeling". On Monday, Jude Dzevela Kong (York) shares his research experience in his plenary "How mathematics can save lives: mathematical modeling to support infectious disease-based decision-making" in the morning, and Fok-Shuen Leung (UBC) shares his teaching experience in his Excellence in Teaching Award lecture "Making the Grade". *continued on next page*

SCIENTIFIC DIRECTOR'S WELCOME LETTER

continued...This meeting would not be possible without the extensive planning and legwork of the staff Canadian Mathematical Society, including particularly Jessica Horowetz and then Sarah Watson (welcome back!), with Executive Director Termeh Kousha as the driving force behind it all. Huge thanks to them for all their work! Also many thanks to the Scientific Organizing Committee --- Alejandro Adem, Andie Burazin, Anna Stokke, Barbara Csima, Emily Cliff, Douglas Farenick and Peter Selinger --- for their support. We are also very grateful to the local sponsors of this meeting --- the Department of Mathematics and Statistics, the Faculty of Science, and the Office of the Vice-President, Research --- as well as to our national sponsors --- AARMS, CRM, Fields, PIMS, Maplesoft and the RBC Foundation --- for supporting our Canadian math community.

Our biggest thanks go to you, the attendees who are coming together again to share mathematics and ideas --- you are what make this event a success! On behalf of the Department of Mathematics and Statistics of the University of Ottawa, we bid you welcome and hope you have a wonderful meeting.

Yours,

Monica Nevins and Aaron Tikuisis, Scientific Directors.

LETTRE DE BIENVENUE DES DIRECTEUR.RICE.S SCIENTIFIQUES

Monica Nevins

Aaron Tikuisis

Bienvenue à la Réunion d'été 2023 de la Société mathématique du Canada! Notre département était ravi de saisir l'occasion d'accueillir la réunion d'été et de vous montrer notre nouvelle maison dans le bâtiment STEM (pour ceux qui auraient connu nos anciens locaux « pittoresques ») … en 2020. Et, bien. Ceci est devenu une réunion virtuelle en été 2021… mais nous sommes maintenant ici et enchanté de vous avoir finalement accueilli à notre campus en 2023!

Notre programme pour cette réunion comprend une variété d'événements, à la fois nouveaux et anciens, avec des activités visant à impliquer tous les membres de notre communauté mathématique --- des étudiants aux professeurs, des enseignants aux chercheurs de l'industrie --- et nous espérons que vous auriez la chance d'en prendre part (et dites-nous ce que vous pensez). L'horaire de la réunion préliminaire comporte des ateliers et des mini-cours; le samedi soir comprend la soirée étudiante toujours aussi populaire; et le dimanche nous nous rendrons au merveilleux lac Dow pour assister au banquet sur l'eau. N'oubliez pas notre tout premier échange de livre, et soyez à l'affût des superbes offres sur les livres et les produits dérivés de la SMC.

Ne manquez pas nos activités à l'heure du dîner : un dîner de mentorat pour les mathématiciennes s'identifiant comme femmes; l'Assemblée générale annuelle des membres de la SMC; et une nouvelle « discussion au coin du feu » avec Alejandro Adem, président du CRSNG, et Mona Nemer, conseillère scientifique en chef du CRSNG, qui sera animée par Douglas Farenick. Ce sera une occasion intime de poser vos questions à propos de l'avenir des mathématiques au Canada.

Nous sommes très excités de partager avec vous une liste d'orateurs et oratrices excellentes représentant une gamme complète et passionnante de mathématiques. John Urschel (Harvard) donne le ton avec une conférence publique « La magie des déterminants » le vendredi avant la réception d'ouverture. Les conférences pendant le Samedi se concentre sur les mathématiques pures, avec la conférence plénière « Flexibilité dans la géométrie de contact et la géométrie symplectique » par Emmy Murphy (Princeton) durant la matinée et la conférence du prix Jeffery-Williams « ζ(3), log2, et π » par Kumar Murty (Toronto) durant l'après-midi.

Le dimanche matin, Deborah Hughes Hallett (Harvard Kennedy School and University of Arizona) délivra la conférence plénière d'éducation "Exploiter la curiosité des élèves d'aujourd'hui – Les décideurs de demain », tandis que Johanna G. Nešlehová (McGill) délivra sa conférence du prix Krieger-Nelson « Extrême ou pas extrême : Les subtilités et les défis de la modélisation d'événements rares ». Jude Dzevela Kong (York) partagera son expérience dans la recherche durant sa conférence plénière « Comment les mathématiques peuvent sauver des vies : La modélisation mathématique au service de la prise de décision basée en matière de maladies infectieuses » qui se déroulera le lundi matin. Dernièrement, Fok-Shuen Leung (UBC) partagera son expérience en enseignement pendant sa conférence du prix d'Excellence en éducation « La création de la note ». *continuez à la prochaine page*

LETTRE DE BIENVENUE DES DIRECTEUR.RICE.S SCIENTIFIQUES

continué... Cette réunion n'aurait pas été possible sans la planification et du travail considérable du personnel de la Société mathématique du Canada, en particulier Jessica Horowetz et Sarah Watson (bienvenue à nouveau!), avec la directrice générale Termeh Kousha étant la force motrice derrière tout cela. Un grand merci à eux pour tout leur travail! Nous remercions également le comité d'organisation scientifique --- Alejandro Adem, Andie Burazin, Anna Stokke, Barbara Csima, Emily Cliff, Douglas Farenick et Peter Selinger --- pour son soutien. Nous sommes aussi très reconnaissants envers les commanditaires locaux de cette réunion --- le Département de mathématiques et de statistiques, et le Bureau du vice-président, recherche --- ainsi qu'envers nos commanditaires nationaux --- AARMS, CRM, Fields, PIMS, Maplesoft et la Fondation RBC – pour leur soutien à la communauté mathématique canadienne.

Nos plus grands remerciements sont destinés à vous, les participant et participantes qui se réunissent à nouveau dans le but de partager les mathématiques et des idées --- c'est vous qui rendez cet événement un succès! Au nom du Département de mathématiques et de statistiques de l'Université d'Ottawa, nous vous souhaitons la bienvenue et nous espérons que vous passerez une excellente réunion.

Bien à vous,

Monica Nevins and Aaron Tikuisis, Directeur.rice.s scientifiques.

EXCELLENCE IN TEACHING AWARD

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Fok-Shuen Leung of the University of British Columbia has been named the recipient of the 2023 Excellence in Teaching Award for his exceptional contributions to the teaching of mathematics and his work in promoting innovative teaching and learning strategies.

After earning a D.Phil. in Mathematics at Oxford University in 2008, Dr. Leung taught at the University of Waterloo for two years before joining the faculty at UBC. There he immersed himself in a wide range of teaching and curriculum projects, which led to Killam Teaching Prizes in 2012 and 2022, as well as the Pacific Institute for the Mathematical Sciences Education prize in 2020. In that same year, he was promoted to the rank of Professor of Teaching, the highest rank in the (tenured) Educational Leadership track at UBC.

One of his projects involves the development of a course structure in a large first-year calculus courses in which students are given a “small class” experience. The large lectures are supplemented with a weekly session of up to 60 students, during which students learn new material through activities that build their technical skills and deepen their conceptual understanding. To make this program effective, the graduate and undergraduate teaching assistants need to be trained and actively monitored; Fok-Shuen is involved in that as well.

This work connects with a much wider instructor-training program that spans graduate, postdoctoral, and faculty levels. Professor Brian Wetton former Head of the Math Department at UBC says that, “Fok-Shuen has developed a suite of training programs to support the professional development of graduate TAs and postdocs as they learn to become effective instructors. His unique instructional skills orientations for postdocs and the graduate course Mathematics Teaching Techniques, MATH 599, are outstanding, vastly improving our entire teaching mission.”

Dr. Leung publishes and disseminates all this work. His ideas have improved mathematics education at UBC, and in addition, have been formally adopted at the Universities of Waterloo and Alberta. By now, his former trainees are teaching these methods in several Canadian and UK universities, positively affecting mathematics students elsewhere.

Dr. Leung has been engaged in a collaboration with the Nunavut Teacher Education Program at the Nunavut Arctic College in Iqaluit, NU, on teaching and learning mathematics for non-STEM students. This work will have long-term impact on the effectiveness of teachers being trained in Canada’s high Arctic.
Dr. Leung has been a key leader in the development of the Science Stream at UBC’s Vantage College, a program for international students who are simultaneously studying mathematics and learning English.
Overall, Dr. Leung is an outstanding mathematician and educator whose teaching impact is diverse and growing. The CMS is proud to award him the 2023 Excellence in Teaching Award.

PRIX D'EXCELLENCE EN ENSEIGNEMENT 2023

OTTAWA (Ontario) – La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Fok-Shuen Leung, Ph.D., de l'Université de la Colombie-Britannique (UBC), a été nommé récipiendaire du Prix d'excellence en enseignement 2023 pour sa contribution exceptionnelle à l'enseignement des mathématiques et son travail de promotion de stratégies d'enseignement et d'apprentissage novatrices.

Après avoir obtenu un doctorat en mathématiques à Oxford en 2008, M. Leung a enseigné à l'Université de Waterloo pendant deux ans avant de se joindre au corps professoral de l'UBC. Là, il s'est plongé dans un large éventail de projets d'enseignement et de programmes d'études, qui lui ont valu le Prix d'enseignement Killam en 2012 et en 2022, ainsi que le Prix d'enseignement de l'Institut du Pacifique pour les sciences mathématiques en 2020. La même année, il a été promu au rang de « professeur d'enseignement » (Professor of Teaching), le rang le plus élevé dans l'échelle (permanente) du leadership pédagogique à l'UBC.

L'un de ses projets concerne l'élaboration d'une structure de cours de calcul de première année dans lequel le grand groupe a l'expérience d'une « petite classe ». Les cours magistraux sont complétés par une séance hebdomadaire réunissant jusqu'à 60 étudiants, au cours de laquelle ceux-ci apprennent de la nouvelle matière au moyen d'activités qui renforcent leurs compétences techniques et approfondissent leur compréhension conceptuelle. Pour que ce programme soit efficace, les auxiliaires à l'enseignement de premier et de deuxième cycle doivent recevoir une formation et faire l'objet d'un suivi actif; M. Fok-Shuen participe également à ce processus.

Ce travail s'inscrit dans le cadre d'un programme de formation des formateurs beaucoup plus vaste, qui couvre les niveaux du deuxième cycle, postdoctoral et professoral. Le professeur Brian Wetton, ancien directeur du département de mathématiques de l'UBC, précise : « M. Leung a élaboré une série de programmes de formation destinés à favoriser le perfectionnement des auxiliaires à la recherche de deuxième cycle et des postdoctorants qui apprennent à devenir des formateurs efficaces. Ses orientations uniques en matière de compétences pédagogiques pour les postdoctorants et le cours de deuxième cycle sur la pédagogie des mathématiques, MATH 599, sont remarquables et améliorent considérablement l'ensemble de notre mission d'enseignement. »

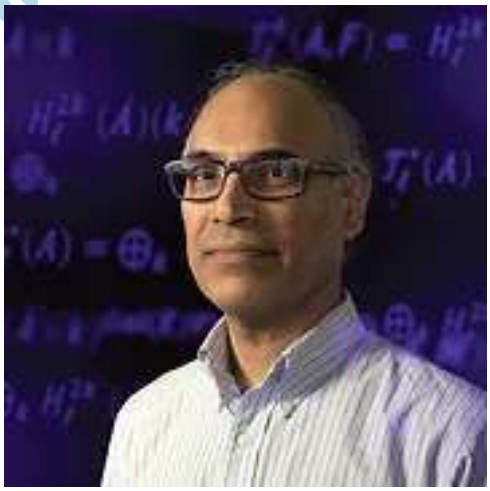
M. Leung publie et diffuse tous ses travaux. Ses idées ont amélioré l'enseignement des mathématiques à l'UBC et ont été officiellement adoptées par les universités de Waterloo et de l'Alberta. Aujourd'hui, ses anciens stagiaires enseignent ces méthodes dans plusieurs universités canadiennes et britanniques, ce qui a un effet positif sur les étudiants en mathématiques d'ailleurs.

M. Leung collabore avec le programme de formation à l'enseignement du Nunavut au Nunavut Arctic College à Iqaluit sur l'enseignement et l'apprentissage des mathématiques pour les étudiants qui ne sont pas en STIM. Ce travail aura un effet à long terme sur l'efficacité du personnel enseignant formé dans le Haut-Arctique canadien.

M. Leung a joué un rôle clé dans le développement de la filière scientifique au Collège Vantage de l'UBC, un programme destiné aux étudiants étrangers qui étudient les mathématiques et apprennent l'anglais en même temps.

Dans l'ensemble, M. Leung est un mathématicien et un pédagogue exceptionnel dont la portée sur l'enseignement est diversifiée et croissante. La SMC est fière de lui décerner son Prix d'excellence en enseignement 2023.

2023 CMS JEFFERY-WILLIAMS PRIZE



The Canadian Mathematical Society (CMS) is pleased to announce Dr. Kumar Murty as recipient of the 2023 CMS Jeffery-Williams Prize for his contributions to mathematical research. Dr. Murty will receive his prize and give a lecture in Ottawa, Ontario at the 2023 CMS Summer meeting in June.

V. Kumar Murty received his doctorate from Harvard University in 1982 as a student of John Tate. In 1987, he was appointed Associate Professor at the University of Toronto, and in 1991 he was promoted to Full Professor. He was Chair of the Department of Mathematics at the University of Toronto during 2008-2013 and again from 2014-2017. He is currently the Director of the Fields Institute for Research in Mathematical Science.

> *Dr. Murty's colleague, Dr. George Elliott, FRSC says, "I am happy to see my colleague's work in number theory and arithmetic geometry recognized with this prestigious award. He has made important contributions over many years, both scientifically, and in general to the discipline." Professor Murty's mathematical interests cover diverse areas including analytic number theory, algebraic number theory, information security, and arithmetic algebraic geometry.*

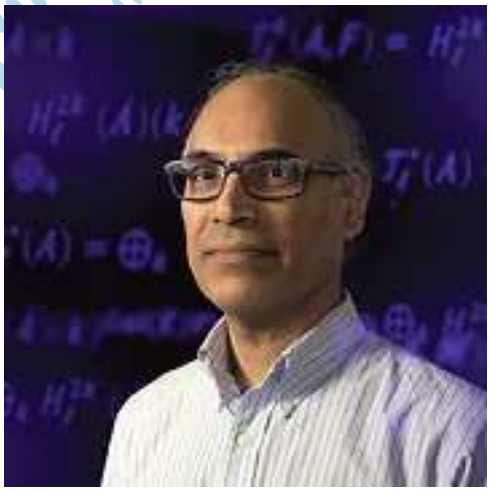
Professor Murty's areas of interest cover several fields, notably analytic number theory, algebraic number theory, information security, and arithmetic and algebraic geometry. His recent work has expanded to mathematical modelling in social, economic and health contexts. This includes his work on Smart Villages and on integrative modelling related to the COVID-19 pandemic.

He has served on the Canadian Mathematical Society Board of Directors and held vice-presidency at the Canadian Mathematical Society. He was elected a Fellow of the Royal Society of Canada in 1995, Fields Institute Fellow in 2003, Fellow of the National Academy of Sciences (India) in 2011, Senior Fellow of Massey College in 2020 and a Fellow of the American Mathematical Society in 2021. He received the Coxeter-James Prize in 1991, the Balaguer Prize (together with M. Ram Murty) in 1996, and the University of Toronto's Inventor of the Year Award in 2011.

> *"I am touched and honoured to receive a prize named after two dedicated professionals, Jeffery and Williams, who did so much to promote the growth and development of mathematical research in Canada." – V. Kumar Murty*

Mr. Murty is a remarkable mathmatician who has contributed greatly to mathematics worldwide. The CMS is delighted to award him the Jeffery-Williams Prize 2023.

PRIX JEFFERY-WILLIAMS 2023 DE LA SMC



OTTAWA (Ontario) – La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Kumar Murty est le récipiendaire du prix Jeffery-Williams 2023 pour sa contribution à la recherche mathématique. M. Murty recevra son prix et donnera une conférence à Ottawa lors de la Réunion d'été 2023 de la SMC en juin.

V. Kumar Murty a obtenu son doctorat à Harvard en 1982 en tant qu'étudiant de John Tate. En 1987, il a été nommé professeur associé à l'University deToronto et, en 1991, il a été promu professeur titulaire. Il a été directeur du département de mathématiques de l'Université de Toronto de 2008 à 2013, puis de 2014 à 2017. Il est actuellement directeur de l'Institut Fields de recherche en sciences mathématiques.

> *Le collègue de M. Murty, George Elliott, Ph.D. et membre de la Société royale du Canada, souligne : « Je suis heureux de voir les travaux de mon collègue dans le domaine de la théorie des nombres et de la géométrie arithmétique récompensés par ce prix prestigieux. M. Murty a grandement contribué aux mathématiques pendant de nombreuses années, tant sur le plan scientifique que sur le plan général de la discipline. »*

Les champs d'intérêt mathématiques du professeur Murty couvrent divers domaines, notamment la théorie analytique des nombres, la théorie algébrique des nombres, la sécurité de l'information et la géométrie arithmétique et algébrique. Ses travaux récents se sont étendus à la modélisation mathématique dans des contextes sociaux, économiques et sanitaires. Il a notamment travaillé sur les villages intelligents et sur la modélisation intégrative liée à la pandémie de COVID-19.

Il a siégé au conseil d'administration de la Société mathématique du Canada et en a assuré la vice-présidence. Il est devenu membre de la Société royale du Canada en 1995, membre du Fields Institute en 2003, membre de la National Academy of Sciences (Inde) en 2011, agrégé supérieur du Massey College en 2020 et membre de l'American Mathematical Society en 2021. Il a reçu le prix Coxeter-James en 1991, le prix Balaguer (avec M. Ram Murty) en 1996 et le prix de l'inventeur de l'année de l'Université de Toronto en 2011.

> *« Je suis touché et honoré de recevoir un prix portant le nom de deux professionnels dévoués, Jeffery et Williams, qui ont tant fait pour favoriser l'essor de la recherche mathématique au Canada. » – V. Kumar Murty*

M. Murty est un mathématicien remarquable qui a grandement contribué aux mathématiques dans le monde entier. La SMC est ravie de lui décerner le prix Jeffery-Williams 2023.

2023 KRIEGER-NELSON PRIZE

The Canadian Mathematical Society is pleased to announce that Dr. Johanna G. Nešlehová (McGill University) has been named the recipient of the 2023 Krieger-Nelson Prize. Dr. Nešlehová is recognized for her exceptional contributions to Statistics, including multivariate analysis, stochastic dependence modeling, and extreme-value theory.

Dr. Nešlehová earned her PhD in Mathematics from Carl-von-Ossietzky-Universität Oldenburg in 2004. Since then, she has built an outstanding academic career with exceptional talent and a high rate of research productivity, with 43 peer-reviewed articles, as well as numerous other publications, including book chapters, conference proceeding articles, popular science articles, editorials, and the like, not to mention a popular undergraduate textbook, written in German no less!

Dr. Nešlehová is a world leader on copula models and their many ramifications in multivariate statistics, notably in relation to risk analysis and extreme-value theory, an area to which she has made numerous outstanding contributions. She is well-known for promoting statistical risk analysis in insurance and finance through her writing and through short courses. She has also made key contributions to the theory of empirical processes and has wide-ranging interests in the application of stochastic dependence and extreme values to climate and finance. In 2019, Dr. Nešlehová was the distinguished recipient of the CRM-SSC Prize in Statistics.

Her work has been published in top-ranked statistical journals, including The Annals of Statistics, ASTIN Bulletin, Biometrika, and the Journal of the American Statistical Association. She is highly engaged in international collaboration, conference speaking and organization, editorial work, and service to the profession. She is currently Editor-in-Chief for The Canadian Journal of Statistics, and she has served as Associate Editor for journals such as Test, the Journal of Multivariate Analysis and Statistics & Risk Modeling. In 2011, she received the distinction of being named an Elected Member of the International Statistics Institute, and in 2020 she was named a Fellow of the Institute of Mathematical Statistics.

In addition to these achievements, Dr. Nešlehová is also a generous and dedicated mentor for young researchers. In 2019, she was recognized for the excellence of her graduate training with the Carrie M. Derick Award for Graduate Supervision and Teaching from McGill University.

In sum, Dr. Nešlehová is an outstanding mathematical statistician and an exemplary role model. Her research accomplishments are all the more impressive given her active engagement in and service to the research community, her dedication to excellent mentorship, and her many other leadership qualities. Johanna G. Nešlehová is an indispensable member of the mathematical community, and the CMS is proud to award her the 2023 Krieger-Nelson Prize.

PRIX KRIEGER-NELSON 2023

La Société mathématique du Canada (SMC) a le plaisir d'annoncer que Johanna G. Nešlehová (Université McGill) a été nommée récipiendaire du prix Krieger-Nelson 2023. La mathématicienne est reconnue pour sa contribution exceptionnelle à la statistique, notamment à l'analyse multivariée, à la modélisation de la dépendance stochastique et à la théorie des valeurs extrêmes.

Mme Nešlehová a obtenu son doctorat en mathématiques à la Carl-von-Ossietzky-Universität d'Oldenburg en 2004. Depuis, elle s'est construit une carrière universitaire remarquable grâce à un talent hors du commun et une grande productivité en recherche : rédaction de 43 articles évalués par des pairs et de nombreuses autres publications, dont des chapitres de livres, des articles d'actes de conférence, des articles de vulgarisation scientifique et des éditoriaux, sans parler d'un manuel populaire pour les études de premier cycle, écrit en allemand de surcroît!

Mme Nešlehová est une sommité mondiale dans le domaine des modèles de copules et de leurs nombreuses ramifications en statistique multivariée, notamment en relation avec l'analyse des risques et la théorie des valeurs extrêmes, un domaine dans lequel ses apports sont nombreux et remarquables. Elle est connue pour promouvoir l'analyse statistique des risques dans les domaines de l'assurance et de la finance par ses écrits et des cours abrégés. Elle a aussi grandement contribué à la théorie des processus empiriques et s'intéresse de près à l'application de la dépendance stochastique et des valeurs extrêmes au climat et à la finance. En 2019, elle a reçu le prix CRM-SSC en statistique.

Ses travaux ont été publiés dans des revues statistiques de premier plan, notamment The Annals of Statistics, ASTIN Bulletin, Biometrika et le Journal of the American Statistical Association. Elle est très investie dans la collaboration internationale, l'organisation et la présentation de conférences, le travail éditorial et le service à la profession. Actuellement rédactrice en chef de la Revue canadienne de statistique, elle a auparavant été rédactrice en chef adjointe de revues comme Test, le Journal of Multivariate Analysis et Statistics & Risk Modeling. En 2011, elle a été nommée membre élue de l'Institut international de statistique et, en 2020, membre de l'Institut de statistique mathématique.

Outre ces accomplissements, Mme Nešlehová est également une mentore généreuse et dévouée pour les jeunes en recherche. En 2019, l'Université McGill lui a décerné le prix Carrie M. Derick pour la supervision et l'enseignement des études supérieures en reconnaissance de l'excellence de sa formation.

Bref, Johanna G. Nešlehová est une statisticienne-mathématicienne exceptionnelle et un modèle exemplaire. Ses réalisations en recherche sont d'autant plus impressionnantes qu'elle s'est engagée activement dans la communauté de la recherche, qu'elle s'est consacrée à l'excellence du mentorat et qu'elle possède de nombreuses autres qualités de leadership. Elle est une membre indispensable de la communauté mathématique, et la SMC est fière de lui décerner le prix Krieger-Nelson 2023.

List of Abbreviations
Liste des abbréviations

AI/ML	Advances in AI/ML and Mathematics for Economics Modelling and Analysis Progrès en matière d'IA/ML et de modélisation et d'analyse économiques
Autofo	Arithmetic aspects of automorphic forms Aspects arithmétiques des formes automorphes
BioStat	Biostatistics Biostatistique
CAlg	C*-algebras and applications Les C*-algèbres et leurs applications
CgameS	Combined Games Session Théorie des jeux combinatoires
DesTheo	Design theory and graph decomposition Théorie des plans et de la décomposition des graphes
DisConG	Interaction of discrete and convex geometry with analysis and combinatorics Interaction de la géométrie discrète et convexe avec l'analyse et la combinatoire
ECareer	Early Career Research in Number Theory Recherche en début de carrière en théorie des nombres
EqSchu	Equivariant Schubert calculus and beyond Calcul de Schubert équivariant et plus encore
ExTeach	Excellence in Teaching Award Prix d'excellence en enseignement
GeoPDE	Geometry for Partial Differential Equations Géométrie pour les équations différentielles partielles
GeoTop	Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics Topologie géométrique, applications pseudo-Anosov et dynamique complexe
GSandE	Group Symmetries and Equivariance in Algebra, Descent, Geometry, and Topology Symétries de groupes et équivariance en algèbre, descente, géométrie et topologie
HopfAlg	Hopf Algebras and Related Topics Algèbres de Hopf et sujets connexes
IBLTech	A conversation on implementations of inquiry-based learning techniques (Panel) A conversation on implementations of inquiry-based learning techniques (Panel)
InAnCon	Interplay Between Analysis and Convexity Interaction entre l'analyse et la convexité
JWPrize	Jefferey-Williams Prize Prix Jefferey-Williams
KNPrize	Krieger-Nelson Prize Prix Krieger-Nelson
LDT	Computational Aspects in Low-Dimensional Topology and Contact Geometry Aspects computationnels de la topologie de basse dimension et de la géométrie de contact
MatModE	Mathematical Modelling of Ecological, Evolutionary and Infectious Disease Dynamics Modélisation mathématique de la dynamique des maladies écologiques, évolutives et infectieuses
MatOp	Matrices and Operators (Bilingual Session) Matrices et opérateurs (session bilingue)
MML	Mathematics of Machine Learning Mathématiques de l'apprentissage automatique
ModPubH	Mathematical modelling in public health Modélisation mathématique en santé publique
NGandMP	Noncommutative Geometry and Mathematical Physics Géométrie non commutative et physique mathématique
NonAlgG	Noncommutative Algebra and Noncommutative Geometry Algèbre et géométrie non commutative
NuMePDE	Numerical Methods for Partial Differential Equations Méthodes numériques pour les équations différentielles partielles

OPRes	Applying mathematics to operations research and real life problems Application des mathématiques à la recherche opérationnelle et aux problèmes de la vie réelle
OpTNDS	Optimal Transport in Natural and Data Sciences La théorie du transport dans les sciences naturelles et informatiques
p-adicg	p-adic groups and representations in the Langlands program Groupes p-adiques et représentations dans le programme de Langlands
PlenLec	Plenary Lectures Conférences plénières
Poster	AARMS-CMS Student Poster Session Présentations par affiches des étudiants - AARMS-SMC
PubLec	Public Lecture Conférence publique
QuaForm	Quadratic forms and Linear algebraic groups Formes quadratiques et groupes algébriques linéaires
QuaInfo	Quantum Information Theory Session Théorie de l'information quantique
RAinMF	Recent Advances in Mathematical Finance Progrès récents en finance mathématique
SetTheo	Set theory and its applications Théorie des ensembles et ses applications
Skills	Skills Coaching in the Mathematics Classroom Entraînement des compétences dans les classes de mathématiques
SRT	Student Research Talks Student Research Talks
SShighS	Sophisticated Stories from the High School Classroom Histoires sophistiquées tirées des classes de l'école secondaire
SSNTofR	Special Session in Number Theory in Celebration of the 70th Birthday of Ram Murty Théorie des nombres : à l'occasion du 70e anniversaire de Ram Murty
ThApFF	Theory and Application of Finite Fields Théorie et applications de corps finis

Schedule for Business Meetings
Horaire pour Séances de travail

Friday June 2	**vendredi 2 juin**
12:30 - 16:30	CMS Board of Directors Meeting / Réunion du Conseil d'administration SMC (STEM 101), STEM 101
18:00 - 18:45	Publications Committee / Comité des publications, STEM 664

Saturday June 3	**samedi 3 juin**
12:00 - 13:00	CMS AGM / L'AGA de la SMC (STEM 224), STEM 224

Sunday June 4	**dimanche 4 juin**
13:45 - 15:45	Mathematical Competitions Committee / Comité des concours mathématiques (STEM 410), STEM 410

Monday June 5	**lundi 5 juin**
9:00 - 12:00	Student Committee / Comité des étudiants (STEM 410), STEM 410

Please note the following room changes:
LMX 221 changed to CRXC 240
LMX 257 changed to CRX C309
LMX 258 changed to CRC 308

Schedule for Related Activities
Horaire pour Activités sociales

Friday June 2	vendredi 2 juin
9:00 - 12:00	Mini Course: Mining Complex Networks / Mini-cours: Exploration des réseaux complexes, STEM 664
9:00 - 12:00	Student Writing Workshop, STEM 201
13:00 - 15:00	Workshop: Indigenous Experiences in the Classroom / Expériences autochtones dans la salle de classe, STEM 364
16:00 - 19:30	CMS Book Swap, STEM 117
16:45 - 17:00	Opening and Welcome / Ouverture et bienvenue, STEM 224
18:00 - 19:30	Welcome Reception / Réception de bienvenue, STEM Lobby

Saturday June 3	samedi 3 juin
10:30 - 11:00	Break / Pause, STEM Lobby
11:00 - 12:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, STEM 117
12:00 - 13:30	CMS Women in Math Mentoring Lunch, STEM 207
13:30 - 14:30	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, STEM 117
14:30 - 15:00	Break / Pause, STEM Lobby
19:00 - 21:00	Student Social / Soirée étudiante, Level One Board Game Cafe (14 Waller St.)

Sunday June 4	dimanche 4 juin
10:30 - 11:00	Break / Pause, STEM Lobby
14:30 - 15:00	Break / Pause, STEM Lobby
19:00 - 22:30	Awards Banquet / Banquet de prix, Lago Dow's Lake

Monday June 5	lundi 5 juin
10:30 - 11:00	Break / Pause, STEM Lobby
12:15 - 13:30	Funding, Opportunities & Policy Panel, STEM 224
14:30 - 15:00	Break / Pause, STEM Lobby

Schedule
Horaire

Friday June 2	**vendredi 2 juin**
9:00 - 12:00	Mini Course: Mining Complex Networks / Mini-cours: Exploration des réseaux complexes, Activ, STEM 664
9:00 - 12:00	Student Writing Workshop, Activ, STEM 201
13:00 - 15:00	Workshop: Indigenous Experiences in the Classroom / Expériences autochtones dans la salle de classe, Activ, STEM 364
13:00 - 16:00	Quantum Information Theory Talk and Tutorial: Yuming Zhao (University of Waterloo), *Introduction to quantum self-testing*, QuaInfo (p. 157), STEM 464
16:00 - 19:30	CMS Book Swap, Activ, STEM 117
16:45 - 17:00	Opening and Welcome / Ouverture et bienvenue, Activ, STEM 224
16:45 - 17:00	Welcome, PubLec (p. 40), STEM224
17:00 - 18:00	John Urschel (Harvard), *The Magic of Determinants*, PubLec (p. 40), STEM224
18:00 - 19:30	Welcome Reception / Réception de bienvenue, Activ, STEM Lobby

Saturday June 3 — samedi 3 juin

8:00 - 8:30 Matthew Cheung (York University), *Designing a Developmental Mathematics Course to Support Productive Struggle*, Skills (p. 172), STEM 224

8:00 - 8:30 Karl Dilcher (Dalhousie University), *On a result of Koecher concerning Markov-Apéry type formulas for the Riemann zeta function*, SSNTofR (p. 180), LMX 221

8:00 - 8:30 George Elliott (Toronto), *A generalization of AF algebras*, CAlg (p. 61), LMX 219

8:00 - 8:30 André Fortin (Université Laval), *A discontinuous Galerkin method for stiff ODEs and DDEs*, NuMePDE (p. 144), LMX 418

8:00 - 8:30 Matheus Grasselli (McMaster University), *Green monetary policy*, RAinMF (p. 162), LMX 405

8:00 - 8:30 Melissa Huggan (Vancouver Island University), *The damage number of the product of graphs*, CgameS (p. 66), CRXC 407

8:00 - 8:30 Ashwin Nayak (University of Waterloo), *Optimal lower bounds for Quantum Learning via Information Theory*, QuaInfo (p. 156), LMX 360

8:00 - 8:30 Danny Ofek (University of British Columbia), *On the essential dimension of cycle modules*, QuaForm (p. 151), STEM 464

8:00 - 8:30 Brendan Pass (Alberta), OpTNDS (p. 149), LMX 390

8:00 - 8:30 Zhen Shuang (Memorial University of Newfoundland), *Weighted p-Laplacian Parabolic Equation and Signal Decomposition*, SRT (p. 185), LMX 257

8:00 - 8:50 Marcelo Aguiar (Cornell University, USA), *The Eckmann-Hilton argument in duoidal categories*, HopfAlg (p. 98), LMX 220

8:00 - 9:00 Goong Chen (Texas A&M University), *Animal Motions and Their Fourier Decomposition*, GeoPDE (p. 91), LMX 241

8:30 - 8:55 Ellen Kirkman (Wake Forest University), *Homological Regularities*, NonAlgG (p. 135), LMX 218

8:30 - 9:00 Rylo Ashmore (Memorial University), *Herding cats stuck in trees*, CgameS (p. 65), CRXC 407

8:30 - 9:00 Keegan Dasilva Barbosa (University of Toronto), *Box Ramsey and Canonical Partitions*, SetTheo (p. 168), LMX 258

8:30 - 9:00 Darja Barr (University of Manitoba), *Test Anxiety: Fight or Flight ? !*, Skills (p. 172), STEM 224

8:30 - 9:00 Magdalena Georgescu, *Cuntz-Pimsner algebras arising from C^*-correspondences over commutative C^*-algebras*, CAlg (p. 62), LMX 219

8:30 - 9:00 Eyal Goren (McGill Univeristy), *Foliations on Shimura varieties in positive characteristic*, Autofo (p. 53), LMX 243

8:30 - 9:00 Sam Harris (Northern Arizona University), *Quantum reductions of synchronous games to graph games*, QuaInfo (p. 155), LMX 360

8:30 - 9:00 Vincent Létourneau (University of Ottawa), *Complexity measures and regret bounds in reinforcement learning from classical statistical learning theory*, MML (p. 129), LMX 451

8:30 - 9:00 Eoin Mackall (University of Maryland), *(Formal) Representability of Chow groups using Milnor K-theory*, QuaForm (p. 151), STEM 464

8:30 - 9:00 Hector Pasten (PUC Chile), SSNTofR (p. 181), LMX 221

8:30 - 9:00 Mark Reesor (Wilfrid Laurier University), *Incorporating Climate Risk into Portfolio Credit Risk Models via Distortion*, RAinMF (p. 164), LMX 405

8:30 - 9:00 Sander Rhebergen (University of Waterloo), *Space-time HDG for the advection-diffusion equation on time-dependent domains in the limit of small diffusion*, NuMePDE (p. 145), LMX 418

8:30 - 9:00 William Verreault (Université Laval), *Nonlinear expansions in reproducing kernel Hilbert spaces*, MatOp (p. 133), CRXC 408

8:30 - 9:00 Behnoosh Zamanlooy (McMaster), *Strong Data Processing Inequalities for Locally Differentially Private Mechanisms*, SRT (p. 186), LMX 257

8:30 - 9:10 George Domat (Fields), *Coarse Geometry of Big Mapping Class Groups of Graphs*, GeoTop (p. 87), STEM 201

9:00 - 9:25 Hongdi Huang (Rice University), *Weighted Poisson projective planes*, NonAlgG (p. 135), LMX 218

9:00 - 9:30 Davoud Abdi (University of Calgary), *Counterexample to Conjectures of Bonato-Tardif, Thomassé and Tyomkyn, Future Directions*, SetTheo (p. 167), LMX 258

9:00 - 9:30 Maciej Augustyniak (Université de Montréal), *A Discrete-Time Hedging Framework for Econometric Option Pricing Models*, RAinMF (p. 160), LMX 405

9:00 - 9:30 Baptiste Berlioux (Polytechnique Montréal), *A-stable and high order nonlinear time integration methods based on deferred correction schemes*, NuMePDE (p. 143), LMX 418

9:00 - 9:30 Anthony Bonato (Toronto Metropolitan University), *The Localization Game*, CgameS (p. 65), CRXC 407

9:00 - 9:30 Felix Baril Boudreau (University of Lethbridge), *Arithmetic Rank Bounds for Abelian Varieties*, SSNTofR (p. 179), LMX 221

9:00 - 9:30 Robin Deeley (CU Boulder), *Solenoids and their C*-algebras*, CAlg (p. 61), LMX 219

9:00 - 9:30 Mohammad Ali Ahmadpoor Jadehkenary (Carleton), *Uniqueness of optimal plans for multi-marginal mass transport problems via a reduction argument*, OpTNDS (p. 148), LMX 390

9:00 - 9:30 Heejong Lee (University of Toronto), *Emerton-Gee stacks for* GSp_4 *and Serre weight conjectures*, Autofo (p. 54), LMX 243

9:00 - 9:30 Michael Li (University of Alberta), *An Epidemic Enigma: Challenges in Modeling the Influenza Epidemic in a Boarding School*, ModPubH (p. 123), LMX 242

9:00 - 9:30 Hermie Monterde (University of Manitoba), *Low fidelity quantum transmission*, QuaInfo (p. 156), LMX 360

9:00 - 9:30 Nathan Pagliaroli (Western University, Canada), *Liouville Quantum gravity from Noncommutative Geometry*, NGandMP (p. 139), LMX 254

9:00 - 9:30 Pierre-Olivier Parisé (University of Hawai at Manoa), *Divergence of Taylor Series in de Branges-Rovnyak Spaces*, MatOp (p. 132), CRXC 408

9:00 - 9:30 Fabian Parsch (University of Toronto), *Teaching and assessing student writing in two-stage team assignments*, Skills (p. 174), STEM 224

9:00 - 9:30 Zinovy Reichstein (University of British Columbia), *The Jordan property of Cremona groups and essential dimension*, QuaForm (p. 151), STEM 464

9:00 - 9:30 Daniel Spector (Taiwan Normal University), GeoPDE (p. 92), LMX 241

9:00 - 9:30 Tiffany Vlaar (Mila), *Constrained and Multirate Training of Neural Networks*, MML (p. 130), LMX 451

9:00 - 9:30 Chengjun Yue (Memorial University of Newfoundland), *Three Diffusion-wave Models with Nonlocal Operators for Image Denoising*, SRT (p. 186), LMX 257

9:00 - 9:50 Miodrag Iovanov (University of Iowa, USA), HopfAlg (p. 99), LMX 220

9:10 - 9:50 Mariam Al-Hawaj (University of Toronto), *Generalized pseudo-Anosov Maps and Hubbard Trees*, GeoTop (p. 86), STEM 201

9:30 - 9:55 Xingting Wang (Howard University), *Poisson Valuation*, NonAlgG (p. 136), LMX 218

9:30 - 10:00 Jean-François Bégin (Simon Fraser University), *A general option pricing framework for affine fractionally integrated models*, RAinMF (p. 160), LMX 405

9:30 - 10:00 Ludovick Bouthat (Université Laval), *Weighted averages of* ℓ^p *sequences: New generalizations of Hardy's inequality*, MatOp (p. 131), CRXC 408

9:30 - 10:00 Ankana Dey (Université de Sherbrooke), *Metacommunity Theory : Adapting for the Human Microbiome*, SRT (p. 184), LMX 257

9:30 - 10:00 Adolfo-Vargas Jimenez (Ottawa), *Dispersion Interactions in the Strictly Correlated Electron Limit of DFT via Multi-Marginal Optimal Transp*, OpTNDS (p. 148), LMX 390

9:30 - 10:00 Nathaniel Johnston (Mount Allison University), *Absolute k-Incoherence and Antidistinguishability*, QuaInfo (p. 155), LMX 360

9:30 - 10:00 Trent Marbach (Toronto Metropolitan University), *The one-visibility localization game*, CgameS (p. 67), CRXC 407

9:30 - 10:00 Antoine Poulin (McGill University), *Borel complexity of Archimedean orders on finitely generated group*, SetTheo (p. 169), LMX 258

9:30 - 10:00 Brad Rodgers (Queen's), *Distances between zeros of L-functions at small and large scales*, SSNTofR (p. 181), LMX 221

9:30 - 10:00 Cameron Ruether (Memorial University), *Cohomological Obstructions to Quadratic Pairs over Schemes.*, QuaForm (p. 151), STEM 464

9:30 - 10:00 Pawel Sarkowicz (Ottawa), *Polar decomposition in algebraic K-theory*, CAlg (p. 63), LMX 219

9:30 - 10:00 Diana Skrzydlo (University of Waterloo), *Teaching and Assessing Professional Skills*, Skills (p. 175), STEM 224

9:30 - 10:00	Seth Taylor (McGill University), *A characteristic mapping method for incompressible hydrodynamics on a rotating sphere*, NuMePDE (p. 146), LMX 418
9:30 - 10:00	Luuk Verhoeven (Western University, Canada), *Fermionic fuzzy geometries*, NGandMP (p. 141), LMX 254
9:30 - 10:00	Ping Yan (Public Health Agency of Canada), *A proportional incidence rate model for aggregated data on vaccine effectiveness against COVID-19 hospital/ICU admissions*, ModPubH (p. 125), LMX 242
9:30 - 10:00	Haizhao Yang (University of Maryland), *Finite Expression Method: A Symbolic Approach for Scientific Machine Learning*, MML (p. 130), LMX 451
9:30 - 10:00	Deping Ye (Memorial University), *Mou He Fang Gai: A legend over thousands years*, GeoPDE (p. 93), LMX 241
9:50 - 10:30	Mireille Soergel (ETH), *An introdution to Dyer groups*, GeoTop (p. 89), STEM 201
10:00 - 10:25	Kenny De Commer (Vrije Universiteit Brussel, Belgium), *Doi-Koppinen modules and quantized Harish-Chandra modules*, HopfAlg (p. 98), LMX 220
10:00 - 10:25	Matthew Satriano (University of Waterloo), *Noncommutative surfaces and stacky surfaces*, NonAlgG (p. 135), LMX 218
10:00 - 10:30	Courtney Allen (University of Guelph), *A de novo implementation of the Anaerobic Digestion Model 1 raises questions about computational speed*, SRT (p. 183), LMX 257
10:00 - 10:30	Francis Aznaran (Oxford), *Transformations for Piola-mapped elements*, NuMePDE (p. 142), LMX 418
10:00 - 10:30	Ruiyuan Chen (University of Michigan), *Quasi-treeable equivalence relations*, SetTheo (p. 168), LMX 258
10:00 - 10:30	David Cui (Massachusetts Institute of Technology), *Sum-of-squares decompositions and nonlocal games*, QuaInfo (p. 154), LMX 360
10:00 - 10:30	Danny Dyer (Memorial University of Newfoundland), *The cheating robot on graph products*, CgameS (p. 65), CRXC 407
10:00 - 10:30	Kimon Fountoulakis (University of Waterloo), *Graph Attention Retrospective*, MML (p. 128), LMX 451
10:00 - 10:30	Sitanshu Gakkhar (Caltech, USA), *A quantum stochastic approach to spectral action*, NGandMP (p. 138), LMX 254
10:00 - 10:30	Boyu Li (Windsor/New Mexico State), *Examples of self-similar actions and imprimitivity theorems*, CAlg (p. 62), LMX 219
10:00 - 10:30	Michael WZ Li (Public Health Agency of Canada), *The Past, Present and the Future of Mathematical Modeling Supporting Public Health*, ModPubH (p. 123), LMX 242
10:00 - 10:30	Nataliia Monina (Ottawa), *Multimarginal Optimal Transport with Neural Networks*, OpTNDS (p. 149), LMX 390
10:00 - 10:30	Erhard Neher (University of Ottawa), *Knebusch's norm principle revisited*, QuaForm (p. 151), STEM 464
10:00 - 10:30	Rajesh Pereira (University of Guelph), *Linear maps which preserve convex sets and their geometric and spectral properties*, MatOp (p. 132), CRXC 408
10:00 - 10:30	Asmita Sodhi (University of Victoria), *Developing Metacognitive Skills through Guided Reflection*, Skills (p. 175), STEM 224
10:00 - 10:30	François Watier (UQAM), *A Weighted Mean-Variance Portfolio Under a No-Bankruptcy Constraint*, RAinMF (p. 165), LMX 405
10:00 - 10:30	Siman Wong (UMass-Amherst), SSNTofR (p. 182), LMX 221
10:00 - 10:40	Parisa Fatheddin (Ohio State University), *Asymptotic Behavior of Stochastic Navier-Stokes and Schrodinger Equations*, GeoPDE (p. 91), LMX 241
10:30 - 11:00	Break / Pause, Activ, STEM Lobby
11:00 - 12:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Activ, STEM 117
11:00 - 12:00	Emmy Murphy (Princeton), *Flexibility in contact and symplectic geometry*, PlenLec (p. 41), STEM 224
12:00 - 13:30	CMS Women in Math Mentoring Lunch, Activ, STEM 207
13:30 - 14:30	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Activ, STEM 117
13:30 - 14:30	Dr. Kumar Murty (Fields), *$\zeta(3)$, $\log 2$, and π*, JWPrize (p. 43), STEM 224
14:30 - 15:00	Break / Pause, Activ, STEM Lobby
15:00 - 15:25	Emily Cliff (Université de Sherbrooke), *Twisted sheaves and quasi-universal bundles*, NonAlgG (p. 134), LMX 218

15:00 - 15:25 Chris Eagle (University of Victoria), *Simulating mathematics research in the classroom*, Skills (p. 173), STEM 224

15:00 - 15:30 Jason Bramburger (Concordia University), *Auxiliary functions as Koopman observables*, MML (p. 128), LMX 451

15:00 - 15:30 Henri Darmon (McGill University), *Generalised Hecke eigenvectors*, Autofo (p. 53), LMX 243

15:00 - 15:30 Heath Emerson (U. Victoria, Canada), *Heisenberg spectral cycles for flows*, NGandMP (p. 137), LMX 254

15:00 - 15:30 Hester Graves (Center for Computing Services), *The minimal Euclidean function on* $\mathbb{Z}[i]$, SSNTofR (p. 180), LMX 221

15:00 - 15:30 Arian Haghparast (York), *Critical probability for phase transition in a degenerate random environment*, SRT (p. 184), LMX 257

15:00 - 15:30 Daihai He (Hongkong Ploytechnic University), *Resolving the enigma of Iquitos and Manaus: A modelling analysis of multiple COVID-19 epidemic waves in two Amazonian cities*, ModPubH (p. 122), LMX 242

15:00 - 15:30 Colin Ingalls (Carleton University), *Quasi-universal representations for finite dimensional algebras*, QuaForm (p. 150), STEM 464

15:00 - 15:30 Christopher Karpinski (McGill University), *Hyperfiniteness of boundary actions of groups*, SetTheo (p. 168), LMX 258

15:00 - 15:30 Annina Lieberherr (University of Oxford), *Optimal Transport distances for classifying electronic excitations*, OpTNDS (p. 149), LMX 390

15:00 - 15:30 Rebecca Milley (Memorial University of Newfoundland - Grenfell Campus), *Progress on misère dicots*, CgameS (p. 67), CRXC 407

15:00 - 15:30 Jamie Mingo (Queen's), *Infinitesimal Freeness*, CAlg (p. 63), LMX 219

15:00 - 15:30 Luis Mora (University of Waterloo), *On the Strictly Uniform Exponential Decay of a Mixed-FEM Discretization for the Wave Equation with Boundary Dissipation*, NuMePDE (p. 144), LMX 418

15:00 - 15:30 Frédéric Morneau-Guérin (TÉLUQ), *Poids de convolution sur* ℓ^2, MatOp (p. 132), CRXC 408

15:00 - 15:30 Egon Schulte (Northeastern University, USA), *Skeletal Uniform Polyhedra*, DisConG (p. 106), LMX 240

15:00 - 15:30 Clarence Simard (UQAM), *Optimal dividend with a proportional bound in a Brownian model*, RAinMF (p. 165), LMX 405

15:00 - 15:30 Brett Stevens (Carleton University), *Non-linearly parameterized pencils of conics in even projective planes*, DesTheo (p. 75), STEM 664

15:00 - 15:30 Misha Tyomkin (Dartmouth), *On numbers associated with a strong Morse function*, LDT (p. 71), LMX 407

15:00 - 15:30 Sherry Wang (University of Ottawa), *Post-quantum Technologies: Password Authentication and Digital Credentials*, QuaInfo (p. 158), LMX 360

15:00 - 15:35 Zelalem Negeri (University of Waterloo), *Identifying and accommodating outlying studies in diagnostic test meta-analyses: a mixture modelling approach*, BioStat (p. 59), STEM 364

15:00 - 15:40 Chong Wang (Washington and Lee University), *Periodic Minimizers of A Ternary Nonlocal Isoperimetric Problem*, GeoPDE (p. 92), LMX 241

15:00 - 15:40 Chenxi Wu (University of Wisconsin), *Sub shift of finite types induced by linear order*, GeoTop (p. 89), STEM 201

15:00 - 15:50 Jean-Simon Pacaud Lemay (Macquarie University, Australia), *Lifting Trace with Hopf Algebras and Hopf Monads*, HopfAlg (p. 99), LMX 220

15:25 - 15:50 Peter Harrington (University of British Columbia), *Group work, reflection, and mathematical communication in a large first year calculus course*, Skills (p. 173), STEM 224

15:30 - 15:55 James Zhang (University of Washington), *Pivotal Automorphisms*, NonAlgG (p. 136), LMX 218

15:30 - 16:00 Christian Bingane (Polytechnique Montreal), *Maximal perimeter of a convex small polygon*, DisConG (p. 103), LMX 240

15:30 - 16:00 Fanch Coudreuse (École normale supérieure de Lyon), *Quantum Optimal Transport and applications to Quantum Gaussian states*, OpTNDS (p. 147), LMX 390

15:30 - 16:00 Alfie Davies (Memorial University of Newfoundland), *Atomic structure and the multiverse*, CgameS (p. 65), CRXC 407

15:30 - 16:00 Jean Deteix (Université Laval), *A projection scheme for the Navier–Stokes/Allan–Cahn model*, NuMePDE (p. 143), LMX 418

15:30 - 16:00 Diba Heydary (University of Toronto), *Adventures in Geometric Topology: An Introduction to the Mapping Class Group*, SRT (p. 184), LMX 257

15:30 - 16:00 Adam Humeniuk (MacEwan), *The lattice of C*-covers of an operator algebra.*, CAlg (p. 62), LMX 219

15:30 - 16:00 Xi Huo (University of Miami), *Vector-borne disease outbreak prevention: linking mosquito trap data to mathematical models*, ModPubH (p. 123), LMX 242

15:30 - 16:00 Homayun Karimi (McMaster), *Mock Seifert matrices and unoriented algebraic concordance*, LDT (p. 70), LMX 407

15:30 - 16:00 Nicole Lemire (Western University), *Toric Models of Algebraic Tori*, QuaForm (p. 151), STEM 464

15:30 - 16:00 Adam Logan (Government of Canada), *A conjectural uniform construction of many rigid Calabi-Yau threefolds*, Autofo (p. 54), LMX 243

15:30 - 16:00 Edward McDonald (Penn State U, USA), *The Dixmier trace and the Density of States*, NGandMP (p. 139), LMX 254

15:30 - 16:00 Samuel Mellick (McGill), *Higher rank groups have fixed price one*, SetTheo (p. 168), LMX 258

15:30 - 16:00 Mathias Neufang (Carleton University), *Non-commutative Fejer theorems, and Arens regularity of the projective tensor product of C*-algebras*, MatOp (p. 132), CRXC 408

15:30 - 16:00 Vakhtang Putkaradze (University of Alberta), *Lie-Poisson Neural Networks*, MML (p. 129), LMX 451

15:30 - 16:00 Jean-François Renaud (UQAM), *Maximization of dividend payments with a concave bound on the dividend rate*, RAinMF (p. 164), LMX 405

15:30 - 16:00 Mateja Sajna (University of Ottawa), *On the directed Oberwolfach problem for complete symmetric equipartite digraphs*, DesTheo (p. 75), STEM 664

15:30 - 16:00 Freydoon Shahidi (Purdue University), *Local Langlands Correspondence and the Internal Structure of Arthur Packets*, SSNTofR (p. 182), LMX 221

15:30 - 16:00 Cunlu Zhou (University of New Mexico), *A singlet projector based NPA hierarchy for the quantum MAXCUT problem*, QuaInfo (p. 158), LMX 360

15:35 - 16:10 Andrea Benedetti (McGill University), *Individual participant data meta analyses*, BioStat (p. 58), STEM 364

15:40 - 16:20 Malavika Mukundan (University of Michigan), *Twisting problems in complex dynamics*, GeoTop (p. 88), STEM 201

15:40 - 16:20 Jerome Quintin (University of Waterloo), *Toward a non-perturbative understanding of a non-singular universe*, GeoPDE (p. 92), LMX 241

15:50 - 16:15 Burcu Tuncer Karabina (University of Waterloo), *The Whys, Whats, and Hows of Feedback*, Skills (p. 174), STEM 224

16:00 - 16:25 Ellen Kirkman (Wake Forest University, USA), *McKay matrices for finite-dimensional Hopf algebras*, HopfAlg (p. 99), LMX 220

16:00 - 16:25 Kelly McKinnie (University of Montana), NonAlgG (p. 135), LMX 218

16:00 - 16:30 Aaron Berk (McGill University), *Variational properties of square root LASSO: Smoothness, uniqueness, explicit solutions*, MML (p. 127), LMX 451

16:00 - 16:30 Alex Clow (Simon Fraser University), *An Alternate Construction of Numbers as Games*, CgameS (p. 65), CRXC 407

16:00 - 16:30 Henri Darmon (McGill University), *Green's functions for RM points.*, SSNTofR (p. 179), LMX 221

16:00 - 16:30 Cédric Dion (Université Laval), *Refined conjectures on Fitting ideals of Selmer groups*, Autofo (p. 53), LMX 243

16:00 - 16:30 Cristian Ivanescu (MacEwan), *Notes on Villadsen algebras*, CAlg (p. 62), LMX 219

16:00 - 16:30 Alice Lacaze-Masmonteil (University of Ottawa), *Resolution of the directed Oberwolfach problem with cycles of equal length*, DesTheo (p. 74), STEM 664

16:00 - 16:30 Nicholas LaRacuente (University of Chicago), *Information Fragility or Robustness of Quantum States and Processes*, QuaInfo (p. 155), LMX 360

16:00 - 16:30 Bryce Morsky (Florida State University), *The impact of threshold decision mechanisms of collective behaviour on disease spread*, ModPubH (p. 124), LMX 242

16:00 - 16:30 Marcu-Antone Orsoni (University of Toronto), MatOp (p. 132), CRXC 408

16:00 - 16:30 Paride Passeli (École Polytechnique Fédérale de Lausanne, Switzerland), *Anisotropic Adaptive Finite Elements for a p-Laplace Like Problem. An Application to Aluminium Electrolysis*, NuMePDE (p. 145), LMX 418

16:00 - 16:30 Alexandre Roch (ESG UQAM), *Optimal dividend and capital injection strategies : a viscosity approach*, RAinMF (p. 164), LMX 405

16:00 - 16:30 Joshua Ruiter (Michigan State), *Coding for algebraic groups*, QuaForm (p. 152), STEM 464

16:00 - 16:30 Ahmad Reza Haj Saeedi Sadegh (Northeastern U, USA), *Deformation Spaces and localized equivariant index formulas for groupoids*, NGandMP (p. 139), LMX 254

16:00 - 16:30 Silas Vriend (McMaster), *On a Free-Endpoint Isoperimetric Problem in* $\mathbb{R}^2$, SRT (p. 185), LMX 257

16:00 - 16:30 Allison Wang (Carnegie Mellon University), *Every CBER is smooth below the Carlson-Simpson generic partition*, SetTheo (p. 170), LMX 258

16:00 - 16:30 Zachary Winkeler (Smith), *Spectral sequence computations in knot Floer homology*, LDT (p. 71), LMX 407

16:00 - 16:30 Deping Ye (Memorial University), *The dual Minkowski problem for unbounded closed hypersurfaces*, DisConG (p. 107), LMX 240

16:10 - 16:45 Audrey Beliveau and Augustine Wigle (University of Waterloo), *Bayesian Unanchored Additive Models for Component Network Meta-Analysis*, BioStat (p. 58), STEM 364

16:15 - 16:40 Ana Duff (Ontario Tech University), *Teaching Problem-Solving Using a Systematic Framework*, Skills (p. 173), STEM 224

16:20 - 17:00 Sami Douba (Institut des Hautes Études Scientifiques), *On regular subgroups of* $\mathrm{SL}_3(\mathbb{R})$, GeoTop (p. 87), STEM 201

16:20 - 17:00 Qi S. Zhang (University of California Riverside), *Log gradient estimates of the heat equation on manifolds.*, GeoPDE (p. 93), LMX 241

16:30 - 16:55 Rajesh Kulkarni (Michigan State University), NonAlgG (p. 135), LMX 218

16:30 - 16:55 Kayla Orlinsky (University of Southern California, USA), *Second indicators of the fusion category* $\mathcal{C}(G, H)$ *where* G *is a coexeter group and* H *is a reflection subgroup*, HopfAlg (p. 99), LMX 220

16:30 - 17:00 Masoomeh Akbari (University of Ottawa), *On the Generalized Honeymoon Oberwolfach Problem*, DesTheo (p. 73), STEM 664

16:30 - 17:00 Mahmud Azam (University of Saskatchewan), *TQFTs and Quantum Computing*, QuaInfo (p. 154), LMX 360

16:30 - 17:00 Ted Bisztriczky (University of Calgary), *A COMBINATORIAL CONSTRUCTION OF BI-CYCLIC 4-POLYTOPES*, DisConG (p. 103), LMX 240

16:30 - 17:00 Jie Chen (McMaster), *The concordance group of flat knots*, LDT (p. 70), LMX 407

16:30 - 17:00 Andrew Dean (Lakehead), *Structure and classification of real* C^**-algebras*, CAlg (p. 61), LMX 219

16:30 - 17:00 Dmitry Evdokimov (Ottawa), *Computational aspects of Optimal Transport: classical and quantum*, OpTNDS (p. 148), LMX 390

16:30 - 17:00 Qiwei Feng (University of Alberta), *High Order Finite Difference Methods for Interface Problems*, NuMePDE (p. 143), LMX 418

16:30 - 17:00 Mikhail Kotchetov (Memorial University), *Graded algebras and quadratic forms*, QuaForm (p. 150), STEM 464

16:30 - 17:00 Anastasis Kratsios (McMaster University), *A Transfer Principle: Universal Approximators Between Metric Spaces From Euclidean Universal Approximators*, MML (p. 128), LMX 451

16:30 - 17:00 Jef Laga (Princeton University), *Rational torsion on abelian surfaces with quaternionic multiplication*, Autofo (p. 54), LMX 243

16:30 - 17:00 Yu-Ru Liu (University of Waterloo), *Equidistribution of Polynomial Sequences in Function Fields*, SSNTofR (p. 181), LMX 221

16:30 - 17:00 Yiannis Loizides (George Mason U, USA), *A fixed-point formula for Dirac operators on Lie groupoids*, NGandMP (p. 139), LMX 254

16:30 - 17:00 Yijun Lou (Hongkong Ploytechnic University), *Getting jab or regular test: observations from an impulsive epidemic COVID-19 model*, ModPubH (p. 124), LMX 242

16:30 - 17:00 Anne Mackay (Université de Sherbrooke), *Optimal stopping with a discontinuous and time-dependent reward function*, RAinMF (p. 163), LMX 405

16:30 - 17:00 Javad Mashreghi (Université Laval), *Carleson measures in classical function spaces*, MatOp (p. 131), CRXC 408

16:30 - 17:00 Achintya Raya Polavarapu (University of Alberta), *Stonean representation of sup-completion of a vector lattice*, SRT (p. 185), LMX 257

16:30 - 17:00 Spencer Unger (University of Toronto), *Flows on the torus*, SetTheo (p. 170), LMX 258

16:30 - 17:00 Thomas Wolf (Brock University), *Families of P-Positions in Chomp*, CgameS (p. 68), CRXC 407

16:40 - 17:05 Anton Mosunov (University of Waterloo), *Problem Solving Sessions and Presentation of Proofs In Advanced Algebra Class*, Skills (p. 174), STEM 224

16:45 - 17:20 Ofir Harari (Core Clinical Sciences, Vancouver), *Network Meta-Interpolation: fast and accurate NMA with effect modification*, BioStat (p. 59), STEM 364

17:00 - 17:25 Stefan Catoiu (DePaul University, USA), *Recent developments in the theory of generalized derivatives via algebra*, HopfAlg (p. 98), LMX 220

17:00 - 17:30 Amir Akbary (University of Lethbridge), *Constants for Artin-like problems*, SSNTofR (p. 179), LMX 221

17:00 - 17:30 Manal Alzahrani (University of Ottawa), *Computing the Faithful Dimension of Certain Classes of p-Groups via the Orbit Method*, SRT (p. 183), LMX 257

17:00 - 17:30 Agnese Barbensi (Melbourne), *Hypergraphs for multiscale cycles in structured data*, LDT (p. 70), LMX 407

17:00 - 17:30 Robert de Keijzer (Eindhoven University of Technology), *Pulse based Variational Quantum Optimal Control for hybrid quantum computing*, OpTNDS (p. 147), LMX 390

17:00 - 17:30 Maude Girardin (École Polytechnique Fédérale de Lausanne, Switzerland), *Error Assessment for a Finite Element - Neural Network Approach Applied to Parametric PDEs*, NuMePDE (p. 144), LMX 418

17:00 - 17:30 Frédéric Godin (Concordia University), *Risk allocation through Shapley decompositions with applications to variable annuities*, RAinMF (p. 162), LMX 405

17:00 - 17:30 Svenja Huntemann (Concordia University of Edmonton), *Temperature of Partizan ArcKayles*, CgameS (p. 66), CRXC 407

17:00 - 17:30 Barry Monson (University of New Brunswick), *The Grand Antiprism*, DisConG (p. 104), LMX 240

17:00 - 17:30 Lucia Moura (University of Ottawa), *Hypergraph-dependent Covering Arrays*, DesTheo (p. 74), STEM 664

17:00 - 17:30 Martina Neuman (Michigan State University), *Superiority of GNN over NN in generalizing bandlimited functions*, MML (p. 129), LMX 451

17:00 - 17:30 Siddarth Sankaran (University of Manitoba), *Arithmetic Siegel-Weil formiulas for zero dimensional varieties.*, Autofo (p. 55), LMX 243

17:00 - 17:30 Ilya Shapiro (U Windsor, Canada), *Hopf-cyclic coefficients for a Hopf algebra in a rigid braided category.*, NGandMP (p. 140), LMX 254

17:00 - 17:30 Dave Touchette (Université de Sherbrooke), QuaInfo (p. 157), LMX 360

17:00 - 17:30 Yanyu Xiao (University of Cincinnati), *Investigations the optimal de-escalation strategies during pandemic*, ModPubH (p. 125), LMX 242

17:00 - 17:40 Rylee Lyman (Rutgers University), *CTs for Free Products*, GeoTop (p. 88), STEM 201

17:05 - 17:30 Jessie Meanwell (McMaster University), *Takeaways from Teacher Desmos: implementing an interactive tool to encourage visual thinking in complex analysis*, Skills (p. 174), STEM 224

17:20 - 17:55 Caitlin Daly (Statistical Software and Advanced Analytics, Cytel Inc), *Comparative effectiveness research in pharma: A statistician's role in demonstrating the value of a new product*, BioStat (p. 58), STEM 364

17:30 - 17:55 Carmen Bruni (University of Waterloo), *Years in the Making - The Story of CS136L*, Skills (p. 172), STEM 224

17:30 - 17:55 Bahram Rangipour (University of New Brunswick, Canada), *Toward the primary conjecture*, HopfAlg (p. 100), LMX 220

17:30 - 18:00 Karoly Bezdek (University of Calgary), *On totally separable packings*, DisConG (p. 103), LMX 240

17:30 - 18:00 Abhishek Bharadwaj (Queen's University), *Linear Relations among special values of L functions*, SSNTofR (p. 179), LMX 221

17:30 - 18:00 Daniele Celoria (Melbourne), *GridPyM: a Python module to handle grid diagrams*, LDT (p. 70), LMX 407

17:30 - 18:00 Muhammad Tariq Javed (Toronto Metropolitan University), *Sequence Covering and Packing Arrays*, DesTheo (p. 74), STEM 664

17:30 - 18:00 Debbie Leung (University of Waterloo), *Rate-Distortion Theory for Mixed States Ensembles*, QuaInfo (p. 156), LMX 360

17:30 - 18:00 Emmanuel Lorin (Carleton University), *Neural network-based discontinuity tracking for hyperbolic conservation laws*, NuMePDE (p. 144), LMX 418

17:30 - 18:00	Adam Metzler (Wilfrid Laurier University), *(Machine) Learning From Transaction-Level Investment Account Data*, RAinMF (p. 164), LMX 405
17:30 - 18:00	Tonatiuh Matos Wiederhold (University of Toronto), *Two-player infinite games on posets*, SRT (p. 185), LMX 257
17:30 - 18:00	Jiacheng Xia (Université Laval), *The convergence problem in Kudla's modularity conjectures*, Autofo (p. 55), LMX 243
19:00 - 21:00	Student Social / Soirée étudiante, Activ, Level One Board Game Cafe (14 Waller St.)

Sunday June 4 — dimanche 4 juin

8:00 - 8:30 Farzane Amirzade (Carleton University), *QC-LDPC construction free of small size elementary trapping sets based on multiplicative subgroups of a finite field*, ThApFF (p. 187), CRXC 408

8:00 - 8:30 Dena Firoozi (HEC Montréal), *LQG Risk-Sensitive Mean Field Games with a Major Agent*, RAinMF (p. 161), LMX 405

8:00 - 8:30 Samprit Ghosh (University of Toronto), *Higher Euler-Kronecker coefficients*, ECareer (p. 79), LMX 257

8:00 - 8:30 Jude Kong (York University), *Mpox dynamic model: incorporating adaptive behavioural changes, control strategies in the MSM community & under-reporting.*, MatModE (p. 116), LMX 242

8:00 - 8:30 Connor Paddock (University of Ottawa), *Satisfiability problems and algebras of boolean constraint system games*, QuaInfo (p. 157), LMX 360

8:00 - 8:30 Alina Stancu (Concordia University), *On convex bodies with sections of prescribed volume*, DisConG (p. 106), LMX 240

8:00 - 8:30 Cameron Stewart (University of Waterloo), *On prime factors of terms of binary recurrence sequences*, SSNTofR (p. 182), LMX 221

8:00 - 8:50 Hongdi Huang (Rice University, USA), *Twisting of graded quantum groups and comodule algebras*, HopfAlg (p. 99), LMX 220

8:30 - 9:00 Alexander Bors (Carleton University), *Wreath products and cascaded feedback shift registers*, ThApFF (p. 187), CRXC 408

8:30 - 9:00 Almut Burchard (University of Toronto), *On pointwise montonicity of heat kernels*, InAnCon (p. 109), LMX 418

8:30 - 9:00 Antonio Cauchi (Concordia University), *Towards new Euler systems for automorphic Galois representations*, Autofo (p. 52), LMX 243

8:30 - 9:00 Eric Culf (University of Waterloo), *Coset states in Uncloneable Cryptography*, QuaInfo (p. 154), LMX 360

8:30 - 9:00 Anastasis Kratsios (McMaster University), *Designing Universal Causal Deep Learning Models: The Geometric (Hyper)Transformer*, RAinMF (p. 162), LMX 405

8:30 - 9:00 Matilde Lalin (Université de Montréal), *The distribution of values of cubic L-functions at $s = 1$*, SSNTofR (p. 180), LMX 221

8:30 - 9:00 Zahra Movahedi Nia (York University), *Predicting Hotspots of Marburg Virus in Africa using Ecological Niche Modeling*, MatModE (p. 118), LMX 242

8:30 - 9:00 Brian Pinsky (Rutgers University), *Groups which are not Automorphism Groups of Graphs*, SetTheo (p. 169), LMX 258

8:30 - 9:00 Andriy Prymak (University of Manitoba), *Convex bodies of constant width with exponential illumination number*, DisConG (p. 105), LMX 240

8:30 - 9:00 Mehdi Salimi (St. Francis Xavier University), *The Strategies for Players to Win in Pursuit-Evasion Differential Games with Various Constraints*, CgameS (p. 67), CRXC 407

8:30 - 9:00 Shuyang Shen (University of Toronto), *On Irreducible Trinomials*, ECareer (p. 81), LMX 257

8:30 - 9:00 Eric Woolgar (University of Alberta), *Uniqueness problems for quasi-Einstein equations*, GeoPDE (p. 93), LMX 241

8:30 - 9:10 Reila Zheng (University of Toronto), *Sharkovsky's Ordering on the Mandelbrot Set*, GeoTop (p. 89), STEM 201

9:00 - 9:25 Kent Vashaw (MIT), *On the decomposition of tensor products of monomial modules for finite 2-groups*, NonAlgG (p. 136), LMX 218

9:00 - 9:30 Dror Bar-Natan (Toronto), *Computing the Zombian of an Unfinished Columbarium*, LDT (p. 69), LMX 407

9:00 - 9:30 Károly Bezdek (University of Calgary), *The Kneser-Poulsen conjecture for uniform contractions revisited*, InAnCon (p. 109), LMX 418

9:00 - 9:30 Jérémy Champagne (University of Waterloo), *Diophantine approximation by linear forms with angular restrictions*, ECareer (p. 77), LMX 257

9:00 - 9:30 Christopher Eagle (University of Victoria), *Counting models of theories in non-first-order logics*, SetTheo (p. 168), LMX 258

9:00 - 9:30 Christoph Frei (University of Alberta), *Principal Trading Arrangements: Optimality under Temporary and Permanent Price Impact*, RAinMF (p. 161), LMX 405

9:00 - 9:30 Rylan Gajek-Leonard (Union College), *Iwasawa invariants of nonordinary modular forms*, Autofo (p. 53), LMX 243

9:00 - 9:30 Tuoxin Li (University of British Columbia), *Beckner's inequality for axially symmetric functions on $\mathbb{S}^4$ and $\mathbb{S}^6$*, GeoPDE (p. 91), LMX 241

9:00 - 9:30 Sébastien Lord (University of Ottawa), *Uncloneable Quantum Advice*, QuaInfo (p. 156), LMX 360

9:00 - 9:30 Steven Miller (Williams College), *Combinatorics in Analyzing L-Function Coefficients and Applications to Low-Lying Zeros*, SSNTofR (p. 181), LMX 221

9:00 - 9:30 Lauren Rose (Bard College), ThApFF (p. 189), CRXC 408

9:00 - 9:30 James Steele (University of Calgary), *Equivariant cohomology and the categorical local Langlands correspondence*, GSandE (p. 95), LMX 390

9:00 - 9:30 Brett Stevens (Carleton University), *Proving simple things about one dimensional snort*, CgameS (p. 68), CRXC 407

9:00 - 9:30 Tommaso Traetta (Università di Brescia), *Generalized Heffter arrays and near alternating sign matrices*, DesTheo (p. 76), STEM 664

9:00 - 9:30 Xiaoying Wang (Trent University), *Studying the mixed transmission in a community with age heterogeneity: COVID-19 as a case study*, ModPubH (p. 124), LMX 242

9:00 - 9:30 Yiming Zhao (Syracuse University, USA), *The Minkowski problem in Gaussian probability space*, DisConG (p. 107), LMX 240

9:00 - 9:50 Xingting Wang (Howard University, USA), *Twisting Manin's universal quantum groups and comodule algebras*, HopfAlg (p. 100), LMX 220

9:00 - 10:30 Presentations and discussion, *Sophisticated Stories from the High School Classroom*, SShighS (p. 176), STEM 224

9:10 - 9:50 Karl Winsor (Fields Institute), *Pseudo-Anosov homeomorphisms and interval maps*, GeoTop (p. 89), STEM 201

9:30 - 9:55 Charles Paquette (Royal Military College of Canada), *Semi-invariant rings and complete intersections*, NonAlgG (p. 135), LMX 218

9:30 - 10:00 Andrii Arman (University of Manitoba), *Upper bounds on the chromatic number of low dimensional spaces*, DisConG (p. 103), LMX 240

9:30 - 10:00 Xiaoning Bian (Dalhousie University), *Generators and relations for 3-qubit Clifford+CS operators*, QuaInfo (p. 154), LMX 360

9:30 - 10:00 Joshua Flynn (McGill University), *Hardy Inequalities and Mean Convex Domains*, InAnCon (p. 110), LMX 418

9:30 - 10:00 Haifeng Hu (McGill University), *Structural Stability for 1D Semiconductor Hydrodynamic Model with Sonic Boundary*, GeoPDE (p. 91), LMX 241

9:30 - 10:00 Ting Han Huang (Concordia University), *Special values of triple product p-adic L-functions and p-adic Abel-Jacobi maps*, ECareer (p. 79), LMX 257

9:30 - 10:00 Nicole Kitt (University of Waterloo), *Characterization of Cofree Representations of $SL_n \times SL_m$*, GSandE (p. 95), LMX 390

9:30 - 10:00 Therese Landry (UC Santa Barbara, USA), *Spectral Triples for Noncommutative Solenoids*, NGandMP (p. 138), LMX 254

9:30 - 10:00 Roman Makarov (Wilfrid Laurier University), *Structural Credit Risk Models with Occupation Times and Spectral Expansions*, RAinMF (p. 163), LMX 405

9:30 - 10:00 Diana Carolina Montoya (Technical University of Vienna), *Maximal independence and singular cardinals*, SetTheo (p. 169), LMX 258

9:30 - 10:00 Kumar Murty (University of Toronto), *Prime divisors of Fourier coefficients of modular forms*, SSNTofR (p. 181), LMX 221

9:30 - 10:00 Dylan Pearson (Mount Allison University), *Slow Localization*, CgameS (p. 67), CRXC 407

9:30 - 10:00 Mark Saaltink (unaffiliated), *An extremal problem in vector spaces over finite fields.*, ThApFF (p. 189), CRXC 408

9:30 - 10:00 Alyssa Sankey (University of New Brunswick), *A family of regular weights on the folded Johnson scheme J(2n,n)*, DesTheo (p. 75), STEM 664

9:30 - 10:00 Mingran Zhang (University of Victoria), *Modeling the Proliferation and Regulation of CD4+ T Cells During an Immune Response*, ModPubH (p. 125), LMX 242

9:30 - 10:20	James Halverson (Northeastern), LDT (p. 70), LMX 407
9:50 - 10:30	Annette Karrer (McGill), *From Stallings' Theorem to connected components of Morse boundaries of graph of groups*, GeoTop (p. 87), STEM 201
10:00 - 10:25	Ryan Aziz (Université Libre de Bruxelles, Belgium), *Generalize Yetter-Drinfeld Modules and Center of Bi-actegories*, HopfAlg (p. 98), LMX 220
10:00 - 10:25	Padmini Veerapen (Tennessee Tech University), *Cocycle twists and Manin's universal quantum groups*, NonAlgG (p. 136), LMX 218
10:00 - 10:30	Michael Bennett (University of British Columbia), *Powerful numbers in arithmetic progression*, SSNTofR (p. 179), LMX 221
10:00 - 10:30	Min Chen (McGill University), *IN-HOMOGENEOUS GAUSS CURVATURE FLOWS*, InAnCon (p. 110), LMX 418
10:00 - 10:30	Emily Cliff (Universite de Sherbrooke), *Principal 2-group bundles and applications*, GSandE (p. 94), LMX 390
10:00 - 10:30	Manuel Fernandez (GeorgiaTech, Atlanta, USA), *On the ℓ_0 Isoperimetry of Measurable Sets*, DisConG (p. 103), LMX 240
10:00 - 10:30	Tony Haddad (Université de Montréal), *A coupling for the prime factors of a random integer*, ECareer (p. 79), LMX 257
10:00 - 10:30	Mary Rose Jerade (University of Ottawa), *So Long Sucker: 2-player, 2-color case*, CgameS (p. 66), CRXC 407
10:00 - 10:30	Delaram Kahrobaei (City University of New York), *Post-quantum hash functions using $SL_n(F_p)$*, ThApFF (p. 188), CRXC 408
10:00 - 10:30	Amin Saeidi (University of Limpopo), *Designs constructed from 2-transitive groups*, DesTheo (p. 75), STEM 664
10:00 - 10:30	Damien Tageddine (McGill U., Canada), *Noncommutative geometry on discrete spaces*, NGandMP (p. 140), LMX 254
10:00 - 10:30	Thomas Theurer (University of Calgary), *Resource theory of quantum thermodynamics: State convertibility from qubit cooling and heating*, QuaInfo (p. 157), LMX 360
10:00 - 10:30	Asger Tornquist (University of Copenhagen), *Almost disjoint families in higher dimensions*, SetTheo (p. 169), LMX 258
10:00 - 10:30	Antony Ware (University of Calgary), *Multi-factor polynomial models for energy commodity markets*, RAinMF (p. 165), LMX 405
10:00 - 10:30	Kazuo Yamazaki (Texas Tech University), *Recent developments for convex integration on fluid PDEs*, GeoPDE (p. 93), LMX 241
10:00 - 10:30	Sicheng Zhao (Queens University), *A Review of Bond Percolation Methods on Epidemic Network Models*, ModPubH (p. 125), LMX 242
10:30 - 11:00	Break / Pause, Activ, STEM Lobby
11:00 - 12:00	Deborah Hughes Hallett (Harvard Kennedy School and University of Arizona), *Harnessing the Curiosity of Today's Students—Tomorrow's Decision Makers*, PlenLec (p. 41), STEM 224
13:30 - 14:30	Dr. Johanna G. Nešlehová (McGill), *Extreme or not extreme: the intricacies and challenges of rare event modeling*, KNPrize (p. 44), STEM 224
14:30 - 15:00	Break / Pause, Activ, STEM Lobby
15:00 - 15:30	Jason Fang and Anton Mosunov (University of Waterloo), *A Lower Bound for the Area of the Fundamental Region of a Binary Form*, ECareer (p. 78), LMX 257
15:00 - 15:30	Hershy Kisilevsky (Concordia University), *Non-Zero Central Values of Dirichlet Twists of Elliptic L-Functions*, SSNTofR (p. 180), LMX 221
15:00 - 15:30	Karol Koziol (CUNY), *Derived K-invariants and the derived Satake transform*, p-adicg (p. 192), STEM 664
15:00 - 15:30	Brett Leroux (University of California at Davis, USA), *Wendel's theorem and the neighborliness of random polytopes*, DisConG (p. 104), LMX 240
15:00 - 15:30	Junling Ma (York University), *Estimating the Effect of Contact Tracing During the Early State of an Epidemic*, MatModE (p. 117), LMX 242
15:00 - 15:30	Ariane Masuda (City University of New York), *On permutation binomials of the form $x^r(x^{q-1}+a)$ over $\mathbb{F}_{q^e}$*, ThApFF (p. 188), CRXC 408

15:00 - 15:30 Mohammadreza Mohajer (University of Ottawa), *Linear relations of p-adic periods of 1-motives*, Autofo (p. 55), LMX 243

15:00 - 15:30 Joanna Olszewska (University of West of Scotland), *The Maths Behind Trustworthy Intelligent Vision Systems*, OPRes (p. 51), CRXC 407

15:00 - 15:30 David Saunders (University of Waterloo), *Bounds on Choquet Integrals in Finite Product Spaces for Capacities with Given Marginals*, RAinMF (p. 165), LMX 405

15:00 - 15:30 Venkata Karthik Timmavajjula (University of New Brunswick, Canada), *Extended diffeomorphism groups for noncommutative manifolds*, NGandMP (p. 140), LMX 254

15:00 - 15:30 Zengle Zhang (Chongqing University of Arts and Sciences), *The (φ, ψ) Orlicz mixed affine and geominimal surface areas*, InAnCon (p. 112), LMX 418

15:00 - 15:35 Richard Cook (University of Waterloo), *Mitigating bias from marker-dependent observation times for internal covariates in Cox regression*, BioStat (p. 58), STEM 364

15:00 - 15:40 Ilya Kazachkov (Fields institute), *Real Cubings*, GeoTop (p. 87), STEM 201

15:00 - 15:40 Xinyang Lu (Lakehead University), *Regularity of equations from epitaxial growth*, GeoPDE (p. 92), LMX 241

15:00 - 15:50 András Juhász (Oxford), *The unknotting number, hard unknot diagrams, and Reinforcement Learning*, LDT (p. 70), LMX 407

15:00 - 15:55 Sean Sanford (Ohio State University, USA), *Non-Split Tambara-Yamagami Categories over the Reals*, HopfAlg (p. 100), LMX 220

15:00 - 17:00 Presentations and discussion, *Sophisticated Stories from the High School Classroom*, SShighS (p. 176), STEM 224

15:30 - 16:00 Francis Anokye (Memorial), *Newfoundland and Labrador Two-Peaked BA.1 Wave*, MatModE (p. 115), LMX 242

15:30 - 16:00 Kristaps Balodis (Calgary), *p-adic analogs of the Kazhdan-Lusztig hypothesis*, p-adicg (p. 191), STEM 664

15:30 - 16:00 Michael Francis (Western University, London, ON, Canada), *Homological unitality of smooth groupoid algebras*, NGandMP (p. 138), LMX 254

15:30 - 16:00 Debanjana Kundu (Fields Institute), *λ-invariant stability in Families of Modular Galois Representations*, Autofo (p. 54), LMX 243

15:30 - 16:00 Luca Lalor (Calgary), *A Numerical Solution to an Algorithmic and HFT Problem with a Jump-Diffusion Price Process*, RAinMF (p. 163), LMX 405

15:30 - 16:00 Howard Li (University of New Brunswick), OPRes (p. 50), CRXC 407

15:30 - 16:00 Matthew Sunohara (University of Toronto), *On stable transfer operators and functorial transfer kernels*, ECareer (p. 81), LMX 257

15:30 - 16:00 Alexandra Szabo (University of Szeged, Hungary), *On the variance of the volume of random polytopes*, DisConG (p. 106), LMX 240

15:30 - 16:00 Hugo Teixeira (Carleton University), *On the functional graph of $f(X) = c(X^{q+1} + aX^2)$ over quadratic extensions of finite fields*, ThApFF (p. 189), CRXC 408

15:30 - 16:00 Beatrice-Helen Vritsiou (University of Alberta), *The Illumination Conjecture for convex bodies with many symmetries*, InAnCon (p. 111), LMX 418

15:30 - 16:00 Gary Walsh (Tutte Institute & Ottawa), *Curves with high rank using Pell equations and Murty sums*, SSNTofR (p. 182), LMX 221

15:35 - 16:10 Grace Yi (University of Western Ontario), *Graphical proportional hazards measurement error models*, BioStat (p. 60), STEM 364

15:40 - 16:20 Shaohua Chen (Cape Breton University), *Global solutions for the 1-D compressible Euler equations with time-dependent damping*, GeoPDE (p. 91), LMX 241

15:40 - 16:20 Harry Petyt (Oxford), *ℓ^p nonpositive curvature*, GeoTop (p. 88), STEM 201

16:00 - 16:30 Ziteng Cheng (Toronto), *Mean field regrets in discrete time games*, RAinMF (p. 161), LMX 405

16:00 - 16:30 Valeriya Kovaleva (Université de Montréal), *Correlations of the Riemann Zeta on the critical line*, ECareer (p. 80), LMX 257

16:00 - 16:30 Siddharth Mahendraker (Boston College), p-adicg (p. 193), STEM 664

16:00 - 16:30 Tyler Meadows (Queen's), *Microbial Competition in a Serial Transfer Culture*, MatModE (p. 118), LMX 242

16:00 - 16:30 Katharina Mueller (Université Laval), *On the Iwasawa invariants of BDP-Selmer groups and BDP p-adic L-functions*, Autofo (p. 55), LMX 243

16:00 - 16:30 Jesus Sanchez Jr. (Washington U. in St Louis, USA), *The Spectral Zeta Cocycle*, NGandMP (p. 140), LMX 254

16:00 - 16:30 Abdellah Sebbar (University of Ottawa), *Modular Differential Equations*, SSNTofR (p. 182), LMX 221

16:00 - 16:30 Zhen Shuang (Memorial University of Newfoundland), *Weighted Laplacian Evolution Equation and Signal Decomposition*, InAnCon (p. 111), LMX 418

16:00 - 16:30 Viktor Vigh (University of Szeged, Hungary), *On random spherical disc-polygons*, DisConG (p. 106), LMX 240

16:00 - 16:30 Thomas Wolf (Brock), *TurboKnots*, LDT (p. 71), LMX 407

16:00 - 16:30 Xi Xie (HuBei University), *On the Niho type locally-APN power functions and their boomerang spectrum*, ThApFF (p. 189), CRXC 408

16:00 - 16:30 Dr. Peter J. Young (Canadian Forces), *A computational stochastic approach for determination of coordinated air defence firing strategies*, OPRes (p. 51), CRXC 407

16:00 - 16:50 Rui Xiong (University of Ottawa, Canada), *Structure algebras, Hopf algebroids and oriented cohomology of a group*, HopfAlg (p. 101), LMX 220

16:10 - 16:45 Eleanor Pullenayegum (The Hospital for Sick Children), *A proposed workflow for handling longitudinal data with irregular assessment times*, BioStat (p. 60), STEM 364

16:20 - 17:00 Paula Burkhardt-Guim (New York University), *ADM mass for C^0 metrics and distortion under Ricci-DeTurck flow*, GeoPDE (p. 90), LMX 241

16:20 - 17:00 Alice Kerr (Bristol), *Loxodromic elements in right-angled Artin groups*, GeoTop (p. 88), STEM 201

16:30 - 17:00 Wen Ai (Memorial University of Newfoundland), *The L_p dual Minkowski problem for unbounded closed convex sets*, InAnCon (p. 109), LMX 418

16:30 - 17:00 Louis Arsenault-Mahjoubi (SFU), *Discrete nonlinear filtering in finance: Applications to stochastic volatility models with jumps*, RAinMF (p. 160), LMX 405

16:30 - 17:00 Balazs Grunfelder (University of Szeged, Hungary), *On asymptotic properties of generalized random polygons*, DisConG (p. 104), LMX 240

16:30 - 17:00 Jeffrey Hatley (Union College), *Vanishing anticyclotomic μ-invariants for non-ordinary modular forms*, Autofo (p. 53), LMX 243

16:30 - 17:00 Daniel Hudson (University of Toronto, Canada), *Weightings for Lie Groupoids and Lie Algebroids*, NGandMP (p. 138), LMX 254

16:30 - 17:00 Simon Kuttner (Carleton University), *Applications of the subset sum problem over finite abelian groups*, ThApFF (p. 188), CRXC 408

16:30 - 17:00 Ram Murty (Queen's University), *The large sieve revisited*, SSNTofR (p. 181), LMX 221

16:30 - 17:00 Du Nguyen (Independent), *Fitting Linear Ordinary Differential Equation and Machine Learning Models using Matrix Frechet derivatives with application in*, OPRes (p. 50), CRXC 407

16:30 - 17:00 Matt Olechnowicz (University of Toronto), *Distribution of preperiodic points in one-parameter families*, ECareer (p. 80), LMX 257

16:30 - 17:00 Thomas Rüd (MIT), *Stable trace formula, orbital integrals, and Tamagawa numbers*, p-adicg (p. 193), STEM 664

16:30 - 17:00 Patricia Sorya (UQAM), *Characterizing slopes: explicit bounds for satellite knots*, LDT (p. 71), LMX 407

16:30 - 17:00 Xiaoying Wang (Trent), *Studying the fear effect in a predator-prey system with apparent competition*, MatModE (p. 120), LMX 242

16:45 - 17:20 Derek Ouyang (Ottawa Hospital Research Institute), *Maintaining the validity of inference in stepped-wedge cluster randomized trials under random effects misspecification*, BioStat (p. 59), STEM 364

17:00 - 17:30 Adèle Bourgeois (TIMC), *Functoriality of Supercuspidal L-packets*, p-adicg (p. 191), STEM 664

17:00 - 17:30 Sourabhashis Das (University of Waterloo), *On the number of irreducible factors with a given multiplicity in function fields*, ECareer (p. 78), LMX 257

17:00 - 17:30 Kirill Golubnichiy (Calgary), *Ill-Posed Problem for the Black-Scholes Equation solution and Machine Learning*, RAinMF (p. 162), LMX 405

17:00 - 17:30 Kinga Nagy (University of Szeged, Hungary), *Best and random approximations with generalized disc-polygons*, DisConG (p. 105), LMX 240

17:00 - 17:30	Fernando Neranga (College of the Holy Cross), *Reversed Dickson polynomials of the (k+1)-th kind over finite fields*, ThApFF (p. 188), CRXC 408
17:00 - 17:30	Stacey Smith ? (Ottawa), *Modelling mutation in equine infectious anemia virus infection suggests a path to viral clearance with repeated vaccination*, MatModE (p. 119), LMX 242
17:00 - 17:30	Gregory van Bavel (Government of Canada), OPRes (p. 51), CRXC 407
17:00 - 17:30	Chengjun Yue (Memorial University of Newfoundland), *A cartoon+texture image decomposition based on interpolation spaces*, InAnCon (p. 112), LMX 418
17:00 - 17:40	Thomas Haettel (CRM Montréal), *Garside groups and nonpositive curvature*, GeoTop (p. 87), STEM 201
17:00 - 17:50	Qing Zhang (Purdue University, USA), *Super-modular categories from near-group centers*, HopfAlg (p. 101), LMX 220
17:20 - 17:55	Sayantee Jana (Indian Institute of Technology), *Robust Inference for Generalized Multivariate Analysis of Variance (GMANOVA) Models*, BioStat (p. 59), STEM 364
17:30 - 18:00	Deniz Enver and Uyen Bao, *We examine the relevance of quantum strategies for deterrence related game theory.*, OPRes (p. 50), CRXC 407
17:30 - 18:00	Ferenc Fodor (University of Szeged, Hungary), *Asymptotic expansions for generalized random polygons*, DisConG (p. 104), LMX 240
17:30 - 18:00	Fiona Murnaghan (Toronto), *Relatively supercuspidal representations*, p-adicg (p. 193), STEM 664
17:30 - 18:00	Liam Orovec (University of Waterloo), *Small Univoque Bases*, ECareer (p. 81), LMX 257
17:30 - 18:00	Carly Rozins (York University), *Why Are Bat-Borne Viruses So Deadly ?*, MatModE (p. 118), LMX 242
19:00 - 22:30	Awards Banquet / Banquet de prix, Activ, Lago Dow's Lake

Monday June 5 — lundi 5 juin

8:00 - 8:30	Michael Li (University of Alberta), *Nonidentifiability in Parameter Estimation of Simple and Complex Epidemic Models*, MatModE (p. 117), LMX 242
8:00 - 8:30	William Verreault (Université Laval), *Sums of arithmetic functions running on factorials*, ECareer (p. 82), LMX 257
8:00 - 8:50	Yilong Wang (BIMSA, China), *Modular tensor categories from SL(2,Z) representations*, HopfAlg (p. 101), LMX 220
8:30 - 9:00	Dennin Hugh (Ohio State), *Bijective proofs of derivative formulas for Schubert polynomials*, EqSchu (p. 83), STEM 464
8:30 - 9:00	Yash Totani (University of Waterloo), *On the problem of representing integers by quadratic forms*, ECareer (p. 81), LMX 257
8:30 - 9:00	Jordan Watts (Central Michigan University), *Weak equivalences between action groupoids*, GSandE (p. 96), LMX 390
8:30 - 9:00	Woldegebriel Assefa Woldegerima (York University), *Modelling the impact of temperature change and rainfall on the spread of vector-borne diseases: malaria as a case study*, MatModE (p. 120), LMX 242
8:30 - 9:00	Jiazu Zhou (Southwest University), *Isoperimetric inequalities for mean curvature integrals*, InAnCon (p. 112), LMX 418
8:30 - 9:30	Panel Discussion and Questions and Answers, IBLTech (p. 45), STEM 224
9:00 - 9:25	Joost Vercruysse (Université Libre de Bruxelles, Belgium), *A Hopf category of Frobenius algebras*, HopfAlg (p. 100), LMX 220
9:00 - 9:30	Wanjun Ai (Southwest University), *A Geometric Constructive Proof for the 2D Discrete Minkowski Problem*, InAnCon (p. 109), LMX 418
9:00 - 9:30	Sonia Gazeau (Université de Montréal), *Constructing virtual patient populations to understand immune responses in immunosuppressed and cancer patients with COVID-19*, MatModE (p. 116), LMX 242
9:00 - 9:30	Xinfen Han (Bank of Canada), *More Than Words: Fed Chairs' Communication During Congressional Testimonies*, AI/ML (p. 48), CRXC 407
9:00 - 9:30	Daniel Johnstone (University of Toronto), *A construction of some Stable Transfer Operators*, ECareer (p. 80), LMX 257
9:00 - 9:30	Jonathan Scott (Cleveland State University), *Algebraic Factorization of Chain Algebra Morphisms*, GSandE (p. 95), LMX 390
9:00 - 9:30	George Seelinger (University of Michigan), *K-theoretic Catalan functions*, EqSchu (p. 84), STEM 464
9:00 - 9:30	E Thompson (Calgary), *A Geometric Algorithm for Computing Zelevinsky Standard Representations.*, p-adicg (p. 193), STEM 664
9:30 - 9:40	Break, IBLTech (p. 45), STEM 224
9:30 - 10:00	Sarah Dijols (Calgary), *Recent progress on the search for representations of G_2 distinguished by SO_4*, p-adicg (p. 192), STEM 664
9:30 - 10:00	Julián Haddad (Universidad de Sevilla), *Higher-order Petty's projection inequality*, InAnCon (p. 110), LMX 418
9:30 - 10:00	Marti Roset Julia (McGill University), *The Gross–Kohnen–Zagier theorem via p-adic uniformization*, ECareer (p. 80), LMX 257
9:30 - 10:00	Chinwendu Madubueze (Federal University of Agriculture, Makurdi), *Modelling transmission dynamics of Lassa fever transmission with environmental pathway transmission*, MatModE (p. 117), LMX 242
9:30 - 10:00	Cristián Bravo Roman (Western University), *Multi-Modal Deep Learning for Midcap Credit Rating Prediction Using Text and Numerical Data*, AI/ML (p. 48), CRXC 407
9:30 - 10:00	Jean-Baptiste Vienney (University of Ottawa), GSandE (p. 95), LMX 390
9:30 - 10:00	Weihong Xu (Virginia Tech), *A presentation for the quantum K ring of partial flag manifolds*, EqSchu (p. 85), STEM 464
9:40 - 10:30	Round Tabel Discussions, IBLTech (p. 45), STEM 224
10:00 - 10:30	Robin Cockett (University of Calgary), *Moore-Penrose Inverses in Dagger Categories*, GSandE (p. 94), LMX 390
10:00 - 10:30	Melissa Emory (OK State), *Beyond Endoscopy via Poisson Summation*, p-adicg (p. 192), STEM 664

10:00 - 10:30	Nic Fellini (Queen's University), *Variations of a conjecture of Ankeny-Artin-Chowla*, ECareer (p. 79), LMX 257
10:00 - 10:30	Mathew Harding (University of California-Irvine), AI/ML (p. 48), CRXC 407
10:00 - 10:30	Dylan Langharst (Kent State University), InAnCon (p. 111), LMX 418
10:00 - 10:30	Rui Xiong (University of Ottawa), *Automorphisms of the Quantum Cohomology of the Springer Resolution and Applications*, EqSchu (p. 84), STEM 464
10:00 - 10:30	Pei Yuan (York University), *Will the vaccination strategies for monkeypox prevent outbreaks at gatherings ? —a case study in Canada*, MatModE (p. 120), LMX 242
10:30 - 11:00	Break / Pause, Activ, STEM Lobby
11:00 - 12:00	Jude Dzevela Kong (York University), *How mathematics can save lives: mathematical modeling to support infectious disease-based decision-making*, PlenLec (p. 41), STEM 224
12:15 - 13:30	Funding, Opportunities & Policy Panel, Activ, STEM 224
13:30 - 14:30	Dr. Fok-Shuen Leung (University of British Columbia), *Making the Grade*, ExTeach (p. 43), STEM 224
14:30 - 15:00	Break / Pause, Activ, STEM Lobby
15:00 - 15:30	Elaheh Abdollahi (York University), *Assessing control strategies and timelines for Mycobacterium tuberculosis elimination, Nunavut as a case study*, MatModE (p. 115), LMX 242
15:00 - 15:30	José Cruz (Calgary), *Vogan's perspective on the local Langlands Correspondence, the Fourier Transform and the Function Sheaf Dictionary*, p-adicg (p. 192), STEM 664
15:00 - 15:30	Mihir Deo (University of Ottawa), *Factorization of unbounded p-adic L-functions*, ECareer (p. 78), LMX 257
15:00 - 15:30	Ajit Desai (Bank of Canada), *Machine Learning Framework for Pattern Recognition and Anomaly Detection in Payments Systems*, AI/ML (p. 47), CRXC 407
15:00 - 15:30	Ferenc Fodor (University of Szeged), *A central limit theorem for the area of random disc-polygons*, InAnCon (p. 110), LMX 418
15:00 - 15:30	Reuven Hodges (University of California San Diego), *Levi-spherical Schubert varieties*, EqSchu (p. 83), STEM 464
15:30 - 16:00	Qing Han (York University), *Evaluation of the impact on pertussis transmission dynamics of adult and maternal boosting programs in the province of Ontario*, MatModE (p. 116), LMX 242
15:30 - 16:00	Malors Espinosa Lara (University of Toronto), *A Symbol from Beyond Endoscopy*, ECareer (p. 80), LMX 257
15:30 - 16:00	Sergii Myroshnychenko (Lakehead University), *How far apart can centroids be ?*, InAnCon (p. 111), LMX 418
15:30 - 16:00	Pierre Siklos (Wilfrid Laurier University), *How Machine Learning Helps Us Understand Central Bank Communication: Some Illustrations*, AI/ML (p. 48), CRXC 407
15:30 - 16:00	James Steele (Calgary), *Koszul duality patterns in the p-adic local Langlands correspondence*, p-adicg (p. 193), STEM 664
15:30 - 16:00	Mihail Tarigradschi (Rutgers), *Classifying cominuscule Schubert varieties up to isomorphism*, EqSchu (p. 84), STEM 464
16:00 - 16:30	Minyoung Jeon (University of Georgia), *Mather classes of Schubert varieties via small resolutions*, EqSchu (p. 83), STEM 464
16:00 - 16:30	Ju-Lee Kim (MIT), p-adicg (p. 192), STEM 664
16:00 - 16:30	Alison Simmons (University of Toronto), *Pneumococcal Transmission Dynamics in Canada: 2010–2019*, MatModE (p. 119), LMX 242
16:00 - 16:30	Vladimir Skavysh (Bank of Canada), *Transformer NLP Models and Quantum Computing for Classification of Receipts Data*, AI/ML (p. 49), CRXC 407
16:00 - 16:30	Xia Zhou (Memorial University of Newfoundland), *On the optimal Orlicz norms and the general dual Musielak Orlicz-Minkowski problems*, InAnCon (p. 113), LMX 418
16:30 - 17:00	Dan Cooney (University of Pennsylvania), *Long-Time Behavior of a PDE Replicator Equation for Multilevel Selection in Group-Structured Populations*, MatModE (p. 115), LMX 242
16:30 - 17:00	Fang Hong (McGill University), *Sharpened Minkowski Inequality in Cartan-Hadamard Spaces*, InAnCon (p. 111), LMX 418

16:30 - 17:00	Nathan Lesnevich (Washington University in St. Louis), *Splines on Cayley Graphs of the Symmetric Group*, EqSchu (p. 84), STEM 464
16:30 - 17:30	Panel Discussion, AI/ML (p. 48), CRXC 407
17:00 - 17:30	Blessing Ogbuokiri (York University), *Vaccine Hesitancy Hotspots in Africa: An Insight From Geotagged Twitter Posts*, MatModE (p. 118), LMX 242
17:00 - 17:30	Fanheng Xu (Memorial University of Newfoundland), *Geometric Sharp Sobolev-type Principle for The Graphic Submanifolds of Euclidean Space*, InAnCon (p. 112), LMX 418
17:30 - 18:00	Yogita Sharma (University of Victoria), *Effect of stochasticity and spatial structure on homing-based gene drive spread*, MatModE (p. 119), LMX 242

Public Lecture
Conférence publique

Schedule/Horaire **Room/Salle: STEM224**

Friday June 2	**vendredi 2 juin**
16:45 - 17:00	Welcome (p. 40)
17:00 - 18:00	John Urschel (Harvard), *The Magic of Determinants* (p. 40)

Abstracts/Résumés

JOHN URSCHEL, Harvard
[Friday June 2 / vendredi 2 juin, 17:00 – STEM224]
The Magic of Determinants

The determinant is one of the first and most fundamental polynomials one encounters in mathematics. Discovered over two centuries ago, far before the notion of a matrix was even formalized, these polynomials remain an important part of modern mathematics. In this lecture, we will talk about all things determinant: history, notable results, and connections to modern problems in many areas of mathematics, including complexity theory, numerical analysis, probability, and others.

WELCOME,
[Friday June 2 / vendredi 2 juin, 16:45 – STEM224]

Plenary Lectures
Conférences plénières

Schedule/Horaire **Room/Salle: STEM 224**

Saturday June 3 — samedi 3 juin

11:00 - 12:00 Emmy Murphy (Princeton), *Flexibility in contact and symplectic geometry* (p. 41)

Sunday June 4 — dimanche 4 juin

11:00 - 12:00 Deborah Hughes Hallett (Harvard Kennedy School and University of Arizona), *Harnessing the Curiosity of Today's Students—Tomorrow's Decision Makers* (p. 41)

Monday June 5 — lundi 5 juin

11:00 - 12:00 Jude Dzevela Kong (York University), *How mathematics can save lives: mathematical modeling to support infectious disease-based decision-making* (p. 41)

Abstracts/Résumés

DEBORAH HUGHES HALLETT, Harvard Kennedy School and University of Arizona

[Sunday June 4 / dimanche 4 juin, 11:00 – STEM 224]

Harnessing the Curiosity of Today's Students—Tomorrow's Decision Makers

Data illuminates many of the world's challenges—climate change, pandemics, inequality, injustice, recessions. Yet over the past few years there has been an uptick in skepticism: climate denial, vaccine hesitancy, and disinformation. What is the role of mathematics in these debates ? This talk will argue that mathematics should embrace a major role. Engaging future citizens with data is our business—and arguably our responsibility—and certainly it is in the interest of society.

How do we engage students in understanding and critiquing data ? We have a powerful ally in students' curiosity. While curiosity can't be dictated, it can be harnessed ! Students see the world through their own lenses, yet we all share the same data. Harnessing their natural curiosity to gain insight into the worlds challenges showcases the mathematical sciences as central to the students' and the world's future.

JUDE DZEVELA KONG, York University

[Monday June 5 / lundi 5 juin, 11:00 – STEM 224]

How mathematics can save lives: mathematical modeling to support infectious disease-based decision-making

Being generally perceived as a niche discipline, mathematical modeling has become extremely popular during the COVID-19 pandemic, being brought to the forefront of lay public attention and debate. Words such as 'flattening the curve' and 'reproduction number' have become a common part of the collective lexicon. In the era of evidence-based decision-making and evidence-based medicine, mathematical models are now considered as valuable and insightful tools as epidemiological surveys and randomized controlled clinical trials. Governmental institutions and public health authorities all over the world are relying more and more on mathematics, not only to forecast the epidemic in terms of trends and projections, but also to understand societal issues, like vaccine hesitancy and behavioral adherence to recommendations and mandates. Never as in this period, mathematicians and mathematical models are playing a key role in real-time delivery of reliable and comprehensive information to predict the spread of COVID-19 and its impact, and in guiding governmental policies and best practice. However, despite this increasing popularity, mathematical modeling still appears to be more an art rather than a science, with results sometimes highly conflicting, which are hard to reconcile. So, HOW do we design a mathematical model of an infectious disease outbreak ? HOW can models be harnessed to inform public health measures at different stages of an outbreak ? In this talk, I will try to provide answers to these questions.

EMMY MURPHY, Princeton University
[Saturday June 3 / samedi 3 juin, 11:00 – STEM 224]
Flexibility in contact and symplectic geometry

There is a notion of flexibility, which acts as a touchstone in a large number of geometric contexts. Originally framed by Gromov as the h-principle, the topic has expanded broadly to influence many fields. The talk will discuss flexibility in symplectic geometry, Stein geometry, and contact geometry, and how the notions of flexibility inter-relate between them. A particular interest here are the flexible/rigid dichotomies we see in these geometries, which has seen rapid progress in recent years. The talk will discuss the general notions and framework, and give a broad tour of recent developments.

Prize Lectures
Conférence des lauréats

Schedule/Horaire **Room/Salle: STEM 224**

Saturday June 3 **samedi 3 juin**

13:30 - 14:30 Dr. Kumar Murty (Fields), $\zeta(3)$, $\log 2$, *and* π (p. 43)

Sunday June 4 **dimanche 4 juin**

13:30 - 14:30 Dr. Johanna G. Nešlehová (McGill), *Extreme or not extreme: the intricacies and challenges of rare event modeling* (p. 44)

Monday June 5 **lundi 5 juin**

13:30 - 14:30 Dr. Fok-Shuen Leung (University of British Columbia), *Making the Grade* (p. 43)

Abstract/Résumé

Excellence in Teaching Award
Prix d'excellence en enseignement

DR. FOK-SHUEN LEUNG, University of British Columbia
[Monday June 5 / lundi 5 juin, 13:30 – STEM 224]
Making the Grade

For most of our undergraduate students, the last – and most lasting – communication they will receive from us is the one telling them their course grade. What does a grade mean ? What do we want it to mean ? And if there's a difference between the two responses, can we find some way to bridge the gap ? In this talk, I'll propose some answers and suggest one way forward.

Jefferey-Williams Prize
Prix Jefferey-Williams

DR. KUMAR MURTY, Fields Institute and University of Toronto
[Saturday June 3 / samedi 3 juin, 13:30 – STEM 224]
$\zeta(3)$, $\log 2$, *and* π

The Riemann zeta function $\zeta(s)$ is defined by

$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s}$$

for $Re(s) > 1$. Special values of the Riemann zeta function at integer points have been studied for centuries. In particular, Euler showed that at positive even integers $2k$, we have $\frac{\zeta(2k)}{\pi^{2k}}$ is rational. For example, $\zeta(2) = \frac{\pi^2}{6}$, $\zeta(4) = \frac{\pi^4}{90}$ and so on.

The values at positive odd integers have remained a mystery. In a posthumous 1785 paper, Euler conjectured that there are rational numbers $\alpha,\ \beta$ so that

$$\zeta(3) = \alpha(\log 2)^3 + \beta\pi^2 \log 2.$$

After reviewing the fascinating story of how Euler came to this conclusion, we describe joint work with Payman Eskandari to show that this conjecture is inconsistent with conjectures in modern algebraic geometry. In particular, we use a conjecture of Grothendieck on periods of mixed motives to show that these three numbers $\zeta(3)$, $\log 2$, and π are in fact algebraically independent !

Thus, the value $\zeta(3)$ remains very enigmatic !

Krieger-Nelson Prize
Prix Krieger-Nelson

DR. JOHANNA G. NEŠLEHOVÁ, McGill

[Sunday June 4 / dimanche 4 juin, 13:30 – STEM 224]

Extreme or not extreme: the intricacies and challenges of rare event modeling

Accounting for dependence between rare events such as severe storms, floods, or large financial losses is essential for sound risk management. This can be accomplished very effectively by combining extreme-value theory with copula modeling, and by relying on the component-wise ranks of multivariate data to make inference. I will first explain how copulas can adequately capture the dependence between extreme events when the commonly used asymptotic extreme-value models are unsuitable. As extending these ideas to a large collection of risks calls for hierarchical models, I will next show how their structure might be inferred by identifying patterns in large-scale rank correlation matrices. Finally, I will use some of these techniques to explore the behavior of the largest claim size in a portfolio of possibly dependent insurance claims.

A conversation on implementations of inquiry-based learning techniques (Panel)

Org: Camelia Karimianpour and/et **Stan Yoshinobu** (University of Toronto)

Inquiry-based learning (or IBL) methods have been implemented in many different forms, from small proof-based undergraduate or graduate courses, to large first-year courses, and in K-12 math classes across North America. In this panel, we will hear from faculty with a diverse set of experiences about how they implement IBL during the first hour, and then break into smaller "round-table" conversations for the second hour. All math instructors interested in IBL are welcome to attend.

Panelists:

Deborah Hughes Hallett, University of Arizona and Harvard Kennedy School Gavin LaRose (virtual), University of Michigan Cindy Blos, University of Toronto Stan Yoshinobu, University of Toronto, Camelia Karimianpour, University of Toronto

The purpose of this panel is to initiate a conversation among those of us who have been practicing IBL in our classes and those who are interested in doing so or are on the fence to exchange ideas, and concerns and explore solutions that may be applied in a variety of settings. We would like to know more about the background and interest of our audience, so that we can tailor the session to your needs. If you are planning to attend our panel, and/or the round table discussions, please take a minute to fill out this form. (https://forms.office.com/r/M2LtjKmFuE)

Les méthodes d'apprentissage inquisitif ("IBL") ont été mises en œuvre sous de nombreuses formes différentes, qu'il s'agisse de petits cours basés sur la preuve, de grands cours de première année ou de cours de mathématiques des écoles maternelles et primaires dans toute l'Amérique du Nord. Dans ce forum, nous entendrons des professeurs ayant des expériences diverses sur la façon dont ils mettent en œuvre l'IBL pendant la première heure, puis nous nous diviserons en petites tables rondes pour la deuxième heure. Tous les professeurs de mathématiques intéressés par l'IBL sont les bienvenus.

Panelists:

Deborah Hughes Hallett, University of Arizona and Harvard Kennedy School Gavin LaRose (virtual), University of Michigan Cindy Blos, University of Toronto Stan Yoshinobu, University of Toronto, Camelia Karimianpour, University of Toronto

The purpose of this panel is to initiate a conversation among those of us who have been practicing IBL in our classes and those who are interested in doing so or are on the fence to exchange ideas, and concerns and explore solutions that may be applied in a variety of settings. We would like to know more about the background and interest of our audience, so that we can tailor the session to your needs. If you are planning to attend our panel, and/or the round table discussions, please take a minute to fill out this form. (https://forms.office.com/r/M2LtjKmFuE)

Schedule/Horaire **Room/Salle: STEM 224**

Monday June 5	**lundi 5 juin**
8:30 - 9:30	Panel Discussion and Questions and Answers (p. 45)
9:30 - 9:40	Break (p. 45)
9:40 - 10:30	Round Tabel Discussions (p. 45)

Abstracts/Résumés

BREAK,
[Monday June 5 / lundi 5 juin, 9:30 – STEM 224]

ROUND TABEL DISCUSSIONS,
[Monday June 5 / lundi 5 juin, 9:40 – STEM 224]

A conversation on implementations of inquiry-based learning techniques (Panel)

PANEL DISCUSSION AND QUESTIONS AND ANSWERS,
[Monday June 5 / lundi 5 juin, 8:30 – STEM 224]

Advances in AI/ML and Mathematics for Economics Modelling and Analysis
Progrès en matière d'IA/ML et de modélisation et d'analyse économiques

Org: Stenio Fernandes and/et **Masoud Nasari** (Bank of Canada)

The Scientific Session on Advances in AI/ML and Mathematics for Economics Modelling and Analysis aims to bring together researchers and practitioners working in the intersection of these fields. The invited talks and selected presentations, from prominent researchers in academia, industry, and central banking, will demonstrate the use of AI/ML and mathematical techniques in economics modelling and analysis, with a focus on applications and case studies. Topics of interest include, but are not limited to, the use of advanced AI and ML techniques and tools for solving complex problems in computational economics, financial modelling, dynamics of economic systems, and the like.

Cette session vise à rassembler les chercheurs et les praticiens travaillant à l'intersection de l'IA/ML et des mathématiques de la modélisation et de l'analyse économiques. En plus des exposés clés invités par d'éminents chercheurs du monde universitaire, de l'industrie et des banques centrales, nous accueillons chaleureusement les candidatures de tous les chercheurs sur des sujets démontrant l'utilisation de l'IA/ML et des techniques mathématiques dans la modélisation et l'analyse économiques, en mettant l'accent sur les applications et les études de cas. Les sujets d'intérêt comprennent, sans s'y limiter, l'utilisation de techniques et d'outils avancés d'IA et de ML pour résoudre des problèmes complexes en économie computationnelle, en modélisation financière, en dynamique des systèmes économiques et dans des domaines connexes.

Schedule/Horaire — Room/Salle: CRXC 407

Monday June 5 — lundi 5 juin

9:00 - 9:30	Xinfen Han (Bank of Canada), *More Than Words: Fed Chairs' Communication During Congressional Testimonies* (p. 48)
9:30 - 10:00	Cristián Bravo Roman (Western University), *Multi-Modal Deep Learning for Midcap Credit Rating Prediction Using Text and Numerical Data* (p. 48)
10:00 - 10:30	Mathew Harding (University of California-Irvine) (p. 48)
15:00 - 15:30	Ajit Desai (Bank of Canada), *Machine Learning Framework for Pattern Recognition and Anomaly Detection in Payments Systems* (p. 47)
15:30 - 16:00	Pierre Siklos (Wilfrid Laurier University), *How Machine Learning Helps Us Understand Central Bank Communication: Some Illustrations* (p. 48)
16:00 - 16:30	Vladimir Skavysh (Bank of Canada), *Transformer NLP Models and Quantum Computing for Classification of Receipts Data* (p. 49)
16:30 - 17:30	Panel Discussion (p. 48)

Abstracts/Résumés

AJIT DESAI, Bank of Canada
[Monday June 5 / lundi 5 juin, 15:00 – CRXC 407]
Machine Learning Framework for Pattern Recognition and Anomaly Detection in Payments Systems

High-value payment systems (HVPS) are a central piece of the financial infrastructure in a country. We propose an novel machine learning (ML) framework for real-time transaction monitoring in such systems. Our framework uses a layered approach. First, we train an ML model based on supervised learning to serve as a payments-classifier to predict the submission time of individual interbank payments. The correctly classified payments are then used in the second layer to study participants' usual payment patterns, while the misclassified payments are analyzed using an unsupervised learning model for the purpose of detecting anomalies. We test our set of models on the payments data from the Canadian HVPS and artificially manipulated transactions. Our results suggest that the layered approach lets us systematically decompose large datasets into usual and unusual payments. This, in turn, allows for transaction-level anomaly detection, which, so far, has been difficult, due to the large size of payments

datasets and the scarcity of anomalies. Our gradient boosting-based payments classifier outperforms traditional models by up to 35

XINFEN HAN, Bank of Canada
[Monday June 5 / lundi 5 juin, 9:00 – CRXC 407]
More Than Words: Fed Chairs' Communication During Congressional Testimonies

Résumé

We study soft information contained in congressional testimonies by the Federal Reserve Chairs and analyze its effects on financial markets. Using machine learning, we construct high-frequency measures of Fed Chair's and Congress members' emotions expressed via their words, voice and face. Increases in the Chair's text-, voice-, or face-emotion indices during the testimony generally raise the S&P500 index and lower the VIX. Stock prices are particularly sensitive to the Fed Chair's answers to questions directly related to monetary policy. The effects during the testimony add up and propagate after the testimony, reaching magnitudes comparable to those after a policy rate cut. Our findings resonate with the view in psychology that communication is much more than words and underscore the need for a holistic approach to central bank communication.

MATHEW HARDING, University of California-Irvine
[Monday June 5 / lundi 5 juin, 10:00 – CRXC 407]

PANEL DISCUSSION,
[Monday June 5 / lundi 5 juin, 16:30 – CRXC 407]

CRISTIÁN BRAVO ROMAN, Western University
[Monday June 5 / lundi 5 juin, 9:30 – CRXC 407]
Multi-Modal Deep Learning for Midcap Credit Rating Prediction Using Text and Numerical Data

The credit rating of a company is a critical factor in determining its financial health and assessing its ability to meet its financial obligations. In this talk, we present a fusion of deep learning models for predicting company credit rating classes using structured and unstructured datasets of different types. The structured datasets used in the model include market, bond, financial ratios, and previous rating information as covariates. An unstructured dataset consisting of earning call transcripts is used to capture additional information that might not be present in the structured data. The models combine different fusion strategies with well-known deep learning models such as Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), and Bidirectional Encoder Representations from Transformers (BERT). We apply data fusion strategies in terms of levels and techniques, including early and intermediate levels, concatenation, and cross-attention techniques. Our results show that a CNN-based multi-modal model with two fusion strategies outperforms other multi-modal techniques. Furthermore, comparing simple architectures with more complicated ones, we find that the more complex deep learning models do not necessarily have the highest performance given the structure of the text data modality. Finally, we compare the impact of different rating agencies on short/medium/long-term performance and find which rating companies have the better performance when predicting future rating movements. The findings of this paper highlight the importance of incorporating unstructured data into credit rating models and provide insights into the effectiveness of different fusion strategies and rating agencies in predicting credit rating classes.

PIERRE SIKLOS, Wilfrid Laurier University
[Monday June 5 / lundi 5 juin, 15:30 – CRXC 407]
How Machine Learning Helps Us Understand Central Bank Communication: Some Illustrations

I draw upon ongoing research with colleagues to illustrate how LLM and topic modelling developments have impacted how economists interpret what central banks communicate. In particular, I summarize relevant contributions from: "Emotion in Euro Area Monetary Policy Communication and Bond Yields: The Draghi Era" (with D. Kanelis) ; "A New Sentiment Indicator for the Euro Area" (with D. Kanelis) "One Money, One Voice ? Evaluating Ideological Positions of Euro Area Central Banks" (with P. Hofmarcher, M. Feldkircher). Versions are available from SSRN.

VLADIMIR SKAVYSH, Bank of Canada
[Monday June 5 / lundi 5 juin, 16:00 – CRXC 407]
Transformer NLP Models and Quantum Computing for Classification of Receipts Data

Automated categorization of goods and services is vital to data analysis of consumer behavior, as well as calculating strategic indices for policy-making. One of the key data sources is the scanner data coming directly from points of sale, where millions of entries containing product descriptions as well as prices are logged in a relatively short period of time. We manually annotate such a dataset, the USDA food product dataset with North American Product Classification System (NAPCS) codes. Then, we propose the use of state-of-the-art neural network transformer models with multi-class softmax layers as well as one-vs-all objectives to train efficient and accurate product description classifiers. Since the data is highly imbalanced, we also experiment in using a generative pretrained language model (GPT2) to perform data augmentation for underrepresented classes and show that this indeed improves weighted accuracy. We further investigate the use of quantum computing as means to improve results in the future.

Applying mathematics to operations research and real life problems
Application des mathématiques à la recherche opérationnelle et aux problèmes de la vie réelle

Org: Uyen Bao (Defence R/D Canada) and/et **Du Nguyen** (USA)

This session is devoted to sharing real-life operations research: challenges and successes. The applications can range from finance, to sensor detection, to quantum games and more. The mathematical techniques include everything from machine learning to variational calculus to number theory. Applications to speak by researchers in this field at all levels is warmly encouraged.

Cette session est consacrée au partage de la recherche opérationnelle dans la vie réelle : défis et réussites. Les applications peuvent aller de la finance à la détection de capteurs, en passant par les jeux quantiques, etc. Les techniques mathématiques comprennent tout, de l'apprentissage automatique au calcul variationnel en passant par la théorie des nombres. Les candidatures de chercheurs dans ce domaine à tous les niveaux sont vivement encouragées.

Schedule/Horaire **Room/Salle: CRXC 407**

Sunday June 4 **dimanche 4 juin**

15:00 - 15:30	Joanna Olszewska (University of West of Scotland), *The Maths Behind Trustworthy Intelligent Vision Systems* (p. 51)
15:30 - 16:00	Howard Li (University of New Brunswick) (p. 50)
16:00 - 16:30	Dr. Peter J. Young (Canadian Forces), *A computational stochastic approach for determination of coordinated air defence firing strategies* (p. 51)
16:30 - 17:00	Du Nguyen (Independent), *Fitting Linear Ordinary Differential Equation and Machine Learning Models using Matrix Frechet derivatives with application in* (p. 50)
17:00 - 17:30	Gregory van Bavel (Government of Canada) (p. 51)
17:30 - 18:00	Deniz Enver and Uyen Bao, *We examine the relevance of quantum strategies for deterrence related game theory.* (p. 50)

Abstracts/Résumés

DENIZ ENVER AND UYEN BAO, Defence R/D Canada
[Sunday June 4 / dimanche 4 juin, 17:30 – CRXC 407]
We examine the relevance of quantum strategies for deterrence related game theory.

It was shown that in fundamental games like the Magic Square, quantum algorithms provide superior results to those of classical algorithms. To model more complex scenarios, we explore the extension of the Magic Square game to higher dimensions. We observe that quantum algorithms remain superior to classical game theory at higher dimensions in the Magic Square game.

Building on this observation on a basic and fundamental game, we investigate the extension of this result on more realistic games such as the Prisoner's Dilemma and how quantum strategies can help players coordinate their decisions to ensure an optimal decision for both in which they will not betray each other (i.e. they will be deterred)

HOWARD LI, University of New Brunswick
[Sunday June 4 / dimanche 4 juin, 15:30 – CRXC 407]

DU NGUYEN, Independent
[Sunday June 4 / dimanche 4 juin, 16:30 – CRXC 407]
Fitting Linear Ordinary Differential Equation and Machine Learning Models using Matrix Frechet derivatives with application in

Applying mathematics to operations research and real life problems
Application des mathématiques à la recherche opérationnelle et aux problèmes de la vie réelle

Using a trace formula recently introduced in [Nguyen, 2022] for the Frechet derivative of an analytic matrix function, we revisit the problem of fitting a model whose state variables are governed by a system of linear differential equations. Applications include fitting the equation for radioactivity in blood samples [Jennrich and Bright, 1976] and fitting financial time series. The trace formula allows us to use a derivative-based solver for both problems. We also discuss other applications of Frechet derivative in numerical calculations, including finding zeros of a function involving matrix exponential in machine learning [Sustik and Dhillon,2012] and finding the Riemannian center of mass (in computer vision) [Chakraborty and Vemuri, 2019].

JOANNA OLSZEWSKA, University of the West of Scotland, UK
[Sunday June 4 / dimanche 4 juin, 15:00 – CRXC 407]
The Maths Behind Trustworthy Intelligent Vision Systems

Nowadays, there is an increased use of AI-based technologies in applications ranging from intelligent agents to autonomous vehicles, from Industry 4.0 to Society 5.0. One of the main challenges posed by all these new-generation intelligent systems is their trustworthiness. Hence, this work presents the mathematical modelling that underlies trustworthy intelligent systems and studies its operational use in context of advanced computer vision applications.

GREGORY VAN BAVEL, Government of Canada
[Sunday June 4 / dimanche 4 juin, 17:00 – CRXC 407]

DR. PETER J. YOUNG, Defence Research and Development Canada
[Sunday June 4 / dimanche 4 juin, 16:00 – CRXC 407]
A computational stochastic approach for determination of coordinated air defence firing strategies

Coordinated air defence involves the determination of a firing strategy across a group of air defence units employing surface-to-air missiles to counter an air raid. A key objective for a firing strategy is to achieve a desired hit probability against each threat in the raid whilst minimising total missile expenditure to counter the raid. Instrumental to this is the adoption of shoot-look-shoot firing policies where possible. The problem is subject to time and resource constraints and is further complicated by uncertainties in threat behaviours as the raid progresses. This paper presents an overview of a computational stochastic method developed for solving this problem in context of naval task group air defence. This method involves the construction of decision trees composed of firing options arising from projections of the threats through the engagement zones for the air defence units. Each firing option captures a possible engagement for a defending unit firing a salvo of one or more missiles against a threat at a specified time. Associated with each firing option is an engagement assessment performed using precomputed missile engagement zones that provide intercept times and hit probabilities for given launch conditions. The decision tree is searched to yield a Pareto efficient boundary for hit probability versus missile expenditure, from which an optimal firing strategy can be obtained. The methodology is now being applied in a fast running ship stationing model to complement physics-based Monte Carlo models for investigating task group air defence.

Arithmetic aspects of automorphic forms
Aspects arithmétiques des formes automorphes

Org: Antonio Lei (University of Ottawa) and/et **Giovanni Rosso** (Concordia University)

Automorphic forms arise naturally in many different settings of Number Theory: from elliptic curves and modular forms to the Langlands program. This session will focus on new developments and their applications, including new constructions of Euler systems via algebraic cycles, and variations of automorphic forms in families.

Les formes automorphes apparaissent naturellement dans de nombreux contextes différents de la théorie des nombres : des courbes elliptiques et des formes modulaires au programme de Langlands. Cette session se concentrera sur les nouveaux développements et leurs applications, y compris les nouvelles constructions de systèmes d'Euler via des cycles algébriques, et les variations des formes automorphes dans les familles.

Schedule/Horaire **Room/Salle: LMX 243**

Saturday June 3 **samedi 3 juin**

8:30 - 9:00	Eyal Goren (McGill Univeristy), *Foliations on Shimura varieties in positive characteristic* (p. 53)
9:00 - 9:30	Heejong Lee (University of Toronto), *Emerton-Gee stacks for GSp_4 and Serre weight conjectures* (p. 54)
15:00 - 15:30	Henri Darmon (McGill University), *Generalised Hecke eigenvectors* (p. 53)
15:30 - 16:00	Adam Logan (Government of Canada), *A conjectural uniform construction of many rigid Calabi-Yau threefolds* (p. 54)
16:00 - 16:30	Cédric Dion (Université Laval), *Refined conjectures on Fitting ideals of Selmer groups* (p. 53)
16:30 - 17:00	Jef Laga (Princeton University), *Rational torsion on abelian surfaces with quaternionic multiplication* (p. 54)
17:00 - 17:30	Siddarth Sankaran (University of Manitoba), *Arithmetic Siegel-Weil formiulas for zero dimensional varieties.* (p. 55)
17:30 - 18:00	Jiacheng Xia (Université Laval), *The convergence problem in Kudla's modularity conjectures* (p. 55)

Sunday June 4 **dimanche 4 juin**

8:30 - 9:00	Antonio Cauchi (Concordia University), *Towards new Euler systems for automorphic Galois representations* (p. 52)
9:00 - 9:30	Rylan Gajek-Leonard (Union College), *Iwasawa invariants of nonordinary modular forms* (p. 53)
15:00 - 15:30	Mohammadreza Mohajer (University of Ottawa), *Linear relations of p-adic periods of 1-motives* (p. 55)
15:30 - 16:00	Debanjana Kundu (Fields Institute), *λ-invariant stability in Families of Modular Galois Representations* (p. 54)
16:00 - 16:30	Katharina Mueller (Université Laval), *On the Iwasawa invariants of BDP-Selmer groups and BDP p-adic L-functions* (p. 55)
16:30 - 17:00	Jeffrey Hatley (Union College), *Vanishing anticyclotomic μ-invariants for non-ordinary modular forms* (p. 53)

Abstracts/Résumés

ANTONIO CAUCHI, Concordia University
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 243]
Towards new Euler systems for automorphic Galois representations

The construction of Euler systems for Galois representations associated to automorphic forms often relies on the existence of Rankin-Selberg integrals which calculate the corresponding L-function. I will discuss a new Rankin-Selberg integral, which

represents a twist of the degree 5 L-function of cusp forms on GSp_4, and its application to the study of the arithmetic of the standard Galois representation associated to cusp forms on GSp_4. This is joint work with Armando Gutierrez.

HENRI DARMON, McGill
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 243]
Generalised Hecke eigenvectors

If M is a module over a Hecke algebra and $v \in M$ is a simulatenous eigenvector for the Hecke operators, a *generalised eigenvector* attached to v is a an element $v' \in M$ satisfying

$$T_\ell v' = a_\ell v' + a'_\ell v.$$

The scalars a'_ℓ often carry rich arithmetic information. When M is the space of forms of weight one, they are logarithms of algebraic numbers and are a key to explicit class field theory for real quadratic fields. I will discuss the case where M is a space of modular forms of weight two with fourier coefficients in $\mathbb{Z}/p\mathbb{Z}$, where these quantites appear to be related to classes in K-theory considered by Beilinson and Flach.

This is an account of work in progress with Alice Pozzi.

CÉDRIC DION, Université Laval
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 243]
Refined conjectures on Fitting ideals of Selmer groups

Fix an odd prime number p and let K_n be the nth layer of the cyclotomic $\mathbb{Z}_p$-extension of $\mathbb{Q}$. Kim and Kurihara showed that the Pontryagin dual of the Selmer group over K_n attached to an elliptic curve E with good ordinary reduction at p is generated by the Mazur-Tate element at level K_n. When the reduction is supersingular at p, they show that the same result holds, up to an explicit error term. In this talk, we discuss generalization of these results for the Selmer group of E over the $\mathbb{Z}_p^2$-extension of an imaginary quadratic field where p splits.

RYLAN GAJEK-LEONARD, Union College
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 243]
Iwasawa invariants of nonordinary modular forms

This talk will outline a method for computing the (analytic) Iwasawa invariants of cuspidal newforms with $a_p = 0$ in terms of the associated sequence of Mazur-Tate elements. The connection between Mazur-Tate elements and p-adic L-functions is well-known for weight two modular forms, but the relation is less clear at higher weights. In the $a_p = 0$ case, we use Pollack's decomposition of the p-adic L-function to construct explicit lifts of Mazur-Tate elements to the full Iwasawa algebra. By studying the behavior of these lifts upon projection to layer n, we relate the Iwasawa invariants of Mazur-Tate elements to those of the corresponding p-adic L-functions. Corollaries include a relation between the Iwasawa invariants attached to certain p-congruent pairs of modular forms and a description of the p-adic valuation of critical L-values for modular forms with $a_p = 0$.

EYAL GOREN, McGill University
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 243]
Foliations on Shimura varieties in positive characteristic

In joint work with E. De Shalit (Hebrew U) we developed a theory of foliations on Shimura varieties in positive characteristic, offering as "case studies" the examples of Hilbert modular varieties and unitary Shimura varieties. Those reveal intimate connections with modular forms mod p, Shimura varieties with parahoric level structure, inseparable morphisms and deformation theory. I will provide an overview, using two particular examples: Hilbert-Blumenthal surfaces and Picard modular surfaces.

Arithmetic aspects of automorphic forms
Aspects arithmétiques des formes automorphes

JEFFREY HATLEY, Union College
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 243]
Vanishing anticyclotomic μ-invariants for non-ordinary modular forms

Let $E_{/\mathbf{Q}}$ be an elliptic curve and p a prime such that $E[p]$ is irreducible as a $G_{\mathbf{Q}}$-module. A fundamental conjecture (due to Greenberg and Perrin-Riou) states that the Iwasawa μ-invariant(s) associated to E over the cyclotomic $\mathbf{Z}_p$-extension of $\mathbf{Q}$ must vanish. Despite many focused efforts, this conjecture is still wide open. One may extend this conjecture to more general modular forms and more general $\mathbf{Z}_p$-extensions of number fields. In this talk, we discuss work (joint with Antonio Lei) which establishes some cases of this conjecture over anticyclotomic $\mathbf{Z}_p$-extensions of imaginary quadratic fields.

DEBANJANA KUNDU, Fields Institute
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 243]
λ-invariant stability in Families of Modular Galois Representations

Consider a family of modular forms, all of whose residual $\pmod p$ Galois representations are isomorphic. It is well-known that their corresponding Iwasawa λ-invariants may vary. We will discuss this variation from a quantitative perspective, providing lower bounds on the frequency with which these λ-invariants grow or remain stable. This is joint work with Jeff Hatley.

JEF LAGA, Princeton University
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 243]
Rational torsion on abelian surfaces with quaternionic multiplication

Mazur classified all possible rational torsion subgroups of elliptic curves over $\mathbb{Q}$. In joint work with Ciaran Schembri, Ari Shnidman and John Voight, we put strong constraints on the torsion subgroup of a class of abelian surfaces whose geometric endomorphism algebra is large, namely an indefinite quaternion algebra. The proof uses quaternion arithmetic, Neron models, and the modularity of abelian surfaces of GL_2-type.

HEEJONG LEE, University of Toronto
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 243]
Emerton-Gee stacks for GSp_4 and Serre weight conjectures

In the Langlands program, we want to construct a certain correspondence between automorphic representations and Galois representations. The meaning of this correspondence can be explained in terms of the L-functions. However, one can also ask how the structure of one side is reflected on the other side. Serre weight conjectures explicitly explain that how (Serre) weights of the automorphic side and the ramification behavior on the Galois side are related. During the first half of my talk, I will discuss the Serre weight conjectures and their relation to local Galois representations. This will motivate us to understand certain Galois deformation rings. Then I will discuss Emerton-Gee stacks (which allows a more geometric approach to Galois representations) and local models of Le-Le Hung-Levin-Morra (which can describe parts of Emerton-Gee stacks explicitly), as well as their generalizations to the group GSp_4.

ADAM LOGAN, Government of Canada
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 243]
A conjectural uniform construction of many rigid Calabi-Yau threefolds

Given a rational Hecke eigenform f of weight 2, Eichler-Shimura theory gives a construction of an elliptic curve over $\mathbb{Q}$ whose associated modular form is f. Mazur, van Straten, and others have asked whether there is an analogous construction for Hecke eigenforms f of weight $k > 2$ that produces a variety for which the Galois representation on its etale H^{k-1} (modulo classes of

cycles if k is odd) is that of f. In weight 3 this is understood by work of Elkies and Schütt, but in higher weight it remains mysterious, despite many examples in weight 4. In this talk I will present a new construction based on families of K3 surfaces of Picard number 19 that recovers many existing examples in weight 4 and produces almost 20 new ones.

MOHAMMADREZA MOHAJER, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 243]
Linear relations of p-adic periods of 1-motives

1-periods are complex numbers arising from degree 1 Betti-de Rham comparison isomorphism or from Deligne 1-motives. Due to Wüstholz, Huber and other research works, Kontsevich-Zagier period conjecture is known for these periods. In our research, we are aiming to draw p-adic analogies with the well-established results that are known for these periods. Specifically, in this talk, we will explore the p-adic periods of curve type. Our main goal is to study the transcendence and linear relations of these p-adic numbers. We will begin by introducing the formalism of p-adic periods where it provides us a tool to state the p-adic period conjecture and the p-adic version of subgroup theorem. We will then move on to the p-adic periods of 1-motives with good reduction which arise from crystalline-de Rham realisations and we will compare them with those p-adic periods coming from p-adic integration theory.

KATHARINA MUELLER, Universite Laval
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 243]
On the Iwasawa invariants of BDP-Selmer groups and BDP p-adic L-functions

Let f_1 and f_2 be weight two Hecke cusp forms with isomorphic residual Galois representations. Let K be an imaginary quadratic field and assume that the generalized Heegner hypothesis holds for the pairs (f_1, K) and (f_2, K). Let K_∞/K be the anticyclotomic $\mathbb{Z}_p$-extension. We will analyze the relation between the Iwasawa invariants of the BDP-Selmer groups over K_∞ and the BDP p-adic L-fucntions for f_1 and f_2.

This is joint work with Antonio Lei and Jiacheng Xia.

SIDDARTH SANKARAN, University of Manitoba
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 243]
Arithmetic Siegel-Weil formiulas for zero dimensional varieties.

The arithmetic Siegel-Weil formula is a conjectural identity, due to Kudla, that predicts relations between certain arithmetic 'special' cycles on Shimura varieties and derivatives of Eisenstein series. In the zero-dimensional case, notable examples include work of Kudla-Rapoport-Yang, Howard, and Andreatta-Goren-Howard-Madapusi ; these results are ultimately proved by an explicit computation.

This talk is part of an ongoing effort to understand these results from a more conceptual point of view ; after reviewing the formula in a simple case, we will place these results in a more general context, and explain how the arithmetic Siegel-Weil formula can be seen as an application of the usual Siegel-Weil formula. The main novelty is the introduction of a p-adic "Green function" in the zero-dimensional setting, mirroring a construction of Kudla at the archimedean place.

JIACHENG XIA, Université Laval
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 243]
The convergence problem in Kudla's modularity conjectures

Kudla's modularity conjectures generalize the classical Gross–Kohnen–Zagier theorem for modular curves and Heegner points to Shimura varieties for orthogonal and unitary groups and special cycles of arbitrary codimensions. These conjectures were confirmed by Yuan–Zhang–Zhang and Liu assuming convergence of the generating series of special cycles over totally real

fields and CM fields. To fill this gap of convergence, in a joint work in progress with Qiao He, we prove an algebraicity result of these generating series which is a crucial step in our approach towards the convergence problem.

Biostatistics
Biostatistique

Org: Caitlin Daly (Cytel Inc.), **Jemila Hamid** (University of Ottawa) and/et **Bouchra Nasri** (Université de Montréal)

This Scientific Session will focus on recent developments of statistical methods applied in biomedical sciences, and will bring together statisticians working in academia, research institutes and industries. The presentations will be organized in two themes. The first theme is focused on methods and analyses of correlated outcomes, including advanced topics on analysis of longitudinal data, analysis of clustered longitudinal data, methodological developments for handling time-to event data with complex structured covariates, recent advanced in bilinear multivariate methods with applications to longitudinal outcomes from skewed distributions. The second theme focuses on evidence synthesis methods, including topics on meta-analysis, bivariate meta-analysis, network meta-analysis as well as evidence synthesis and comparative effectiveness evaluations from an industry perspective.

Cette session scientifique se concentrera sur les développements récents des méthodes statistiques appliquées aux sciences biomédicales et réunira des statisticiens travaillant dans les universités, les instituts de recherche et dans le secteur industriel. Les présentations seront organisées en deux thèmes. Le premier thème est axé sur les méthodes et les analyses de résultats corrélés, y compris des sujets avancés sur l'analyse des données longitudinales, l'analyse des données longitudinales groupées, les développements méthodologiques pour le traitement des données de temps à événement avec des covariables structurées complexes, les avancées récentes dans les méthodes multivariées bilinéaires avec des applications aux résultats longitudinaux à partir de distributions asymétriques. Le deuxième thème se concentre sur les méthodes de synthèse des preuves, y compris des sujets sur la méta-analyse, la méta-analyse bi-variée, la méta-analyse en réseau ainsi que la synthèse des preuves et les évaluations d'efficacité comparative du point de vue de l'industrie.

Schedule/Horaire — Room/Salle: STEM 364

Saturday June 3 — samedi 3 juin

15:00 - 15:35	Zelalem Negeri (University of Waterloo), *Identifying and accommodating outlying studies in diagnostic test meta-analyses: a mixture modelling approach* (p. 59)
15:35 - 16:10	Andrea Benedetti (McGill University), *Individual participant data meta analyses* (p. 58)
16:10 - 16:45	Audrey Beliveau and Augustine Wigle (University of Waterloo), *Bayesian Unanchored Additive Models for Component Network Meta-Analysis* (p. 58)
16:45 - 17:20	Ofir Harari (Core Clinical Sciences, Vancouver), *Network Meta-Interpolation: fast and accurate NMA with effect modification* (p. 59)
17:20 - 17:55	Caitlin Daly (Statistical Software and Advanced Analytics, Cytel Inc), *Comparative effectiveness research in pharma: A statistician's role in demonstrating the value of a new product* (p. 58)

Sunday June 4 — dimanche 4 juin

15:00 - 15:35	Richard Cook (University of Waterloo), *Mitigating bias from marker-dependent observation times for internal covariates in Cox regression* (p. 58)
15:35 - 16:10	Grace Yi (University of Western Ontario), *Graphical proportional hazards measurement error models* (p. 60)
16:10 - 16:45	Eleanor Pullenayegum (The Hospital for Sick Children), *A proposed workflow for handling longitudinal data with irregular assessment times* (p. 60)
16:45 - 17:20	Derek Ouyang (Ottawa Hospital Research Institute), *Maintaining the validity of inference in stepped-wedge cluster randomized trials under random effects misspecification* (p. 59)
17:20 - 17:55	Sayantee Jana (Indian Institute of Technology), *Robust Inference for Generalized Multivariate Analysis of Variance (GMANOVA) Models* (p. 59)

Abstracts/Résumés

Biostatistics
Biostatistique

AUDREY BELIVEAU AND AUGUSTINE WIGLE, University of Waterloo
[Saturday June 3 / samedi 3 juin, 16:10 – STEM 364]
Bayesian Unanchored Additive Models for Component Network Meta-Analysis

Component Network Meta-Analysis (CNMA) models are an extension of standard Network Meta-Analysis models which account for the use of complex treatments in the network. This paper contributes to several statistical aspects of CNMA. First, by introducing a unified notation, we establish that currently available methods differ in the way additivity is assumed, an important distinction that has been overlooked so far. In particular, one model uses a more restrictive form of additivity than the other which we term anchored and unanchored additivity, respectively. We show that anchored additivity can easily be misspecified. Second, given that Bayesian models are often preferred by practitioners, we develop two unanchored Bayesian CNMA models. An extensive simulation study confirms the favorable performance of the novel models. This is the first simulation study to compare the statistical properties of CNMA models in the literature. Finally, the use of our novel models is demonstrated on a real dataset, and the results of CNMA models on the dataset are compared.

ANDREA BENEDETTI, McGill University
[Saturday June 3 / samedi 3 juin, 15:35 – STEM 364]
Individual participant data meta analyses

In this presentation, I will describe the DEPRESSD project, an individual participant data meta analysis (IPDMA) that aims to investigate the diagnostic accuracy of the most common depression screening tools. I will discuss selective cutoff reporting and how IPDMA allowed us to overcome this problem, as well as other approaches to the problem.

RICHARD COOK, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 15:00 – STEM 364]
Mitigating bias from marker-dependent observation times for internal covariates in Cox regression

Studies of chronic disease often involve modelling the relationship between marker processes and disease onset or progression. The Cox regression model is perhaps the most common and convenient approach to analysis in this setting. In most cohort studies, however, biomarker values are only measured intermittently (e.g. at clinic visits) so Cox models often treat biomarker values as fixed at their most recently observed value until they are updated at the next visit. We consider the implications of this convention on the limiting bias of estimators when the marker values themselves impact the intensity for clinic visits. A joint multistate model is described for the marker-failure-visit process which can be fitted to mitigate this bias and an expectation-maximization algorithm is developed. An application to data from a registry of patients with psoriatic arthritis is given for illustration.

CAITLIN DALY, Cytel
[Saturday June 3 / samedi 3 juin, 17:20 – STEM 364]
Comparative effectiveness research in pharma: A statistician's role in demonstrating the value of a new product

As part of the application process for the reimbursement of a new product, a manufacturer must demonstrate the clinical benefit of the product against standard of care (SoC) in a local market. SoC may include several treatment options or "comparators", most of which have not been directly compared to the new product in a head-to-head randomized controlled trial. There are several statistical approaches available to indirectly compare a new product to relevant comparators, including network meta-analysis. In a consultant role, it is important for a statistician to ensure valid indirect treatment comparisons (ITCs) are conducted in the manufacturer's target patient population. As such, a statistician must think outside the modelling box and develop a good understanding of the disease space and comparator evidence ; this will help the statistician assess for potential violations of the assumptions underlying the models. This talk will introduce ITC methods and will discuss how a statistician

plays a role in all stages leading up to a valid ITC, including the collection of evidence, ITC feasibility assessment, ITC methods selection, and dealing with uncertainty.

OFIR HARARI, Core Clinical Sciences
[Saturday June 3 / samedi 3 juin, 16:45 – STEM 364]
Network Meta-Interpolation: fast and accurate NMA with effect modification

Effect modification may cause bias in network meta-analysis (NMA). Existing population adjustment NMA methods use individual patient data to adjust for EM but disregard available subgroup information from aggregated data in the evidence network. Worse yet: these methods often rely on the shared effect modification (SEM) assumption. In this talk, we present Network Meta-Interpolation (NMI): a method using subgroup analyses to adjust for EM that does not assume SEM. The method balances effect modifiers across studies by turning treatment effect (TE) estimates at the subgroup- and study level into TE and standard errors at EM values common to all studies. Simulation results comparing NMI with standard NMA, network meta-regression (NMR) and Multilevel NMR (ML-NMR) will be presented, to demonstrate NMI's dominance in terms of estimation accuracy and CrI coverage, consistently across various scenarios.

SAYANTEE JANA, Indian Institute of Technology, Hyderabad
[Sunday June 4 / dimanche 4 juin, 17:20 – STEM 364]
Robust Inference for Generalized Multivariate Analysis of Variance (GMANOVA) Models

Existing methods for estimating the parameters of the Growth Curve Model (GCM), which is a special case of Generalized Multivariate Analysis of Variance (GMANOVA) models, assume that the underlying distribution for the error terms is multivariate normal. In practical situations, however, we often come across skewed longitudinal data. Simulation studies show that existing normal-based estimators are sensitive to the presence of skewness in the data, where estimators are associated with increased bias and mean square error (MSE), when the normality assumption is violated. In this presentation, we will consider the GCM under multivariate skew normal (MSN) distribution, where the estimators are derived using the expectation maximization (EM) algorithm. We will also present an extension, where the extended growth curve model (EGCM) is used for clustered longitudinal data. We will discuss an extension of the Newton Raphson algorithm, which was used in developing the Restricted Expectation Maximization (REM) algorithm to derive estimators for the EGCM under MSN distribution. We will provide results from a simulation study and illustrate an application using real data sets.

ZELALEM NEGERI, University of Waterloo
[Saturday June 3 / samedi 3 juin, 15:00 – STEM 364]
Identifying and accommodating outlying studies in diagnostic test meta-analyses: a mixture modelling approach

Outlying studies are prevalent in meta-analyses of diagnostic test accuracy studies. Statistical methods for detecting and downweighting the effect of such studies have recently gained the attention of many researchers. These methods dichotomize each study in the meta-analysis as outlying or non-outlying and focus on examining the effect of outlying studies on the summary sensitivity and specificity only. In this work, we develop a random-effects bivariate mixture model for meta-analyzing diagnostic test accuracy studies by accounting for both the within- and across-study heterogeneity in diagnostic test results. Instead of dichotomizing the studies in the meta-analysis, the proposed model generates the probability that each study is outlying and allows assessing the impact of outlying studies on the pooled sensitivity, specificity, and between-study heterogeneity. We illustrate the performance of the developed method on real-life and simulated meta-analytic data.

DEREK OUYANG, Ottawa Hospital Research Institute
[Sunday June 4 / dimanche 4 juin, 16:45 – STEM 364]
Maintaining the validity of inference in stepped-wedge cluster randomized trials under random effects misspecification

Mixed-effect regression is commonly used in stepped-wedge cluster randomized trials (SW-CRTs). A key requirement is to account for the complex correlation structures. Common structures are exchangeable (random intercept), nested exchangeable (random cluster-by-period), and exponential decay (discrete-time decay). In recent years, more complex models (e.g., random intervention models) have been proposed. In practice, it is challenging to specify appropriate random effects and obtain valid statistical inferences. Robust variance estimators (RVE) that have been widely discussed under the generalized estimating equations framework may also be applied in mixed-effect regression to deal with random-effect misspecifications. However, relevant discussion in SW-CRT has been limited. In this study, we first review five RVEs that are available for linear mixed models via R. Then, we describe the results of a simulation study to investigate the performance of RVE under mixed-effect regression. We focused on SW-CRTs with continuous outcomes assuming the data were generated from models with 1) exponential decay and random intervention effects, or 2) random cluster-by-period and random intervention effects. For each data generator, we found that the use of RVE with either the random intercept or the random cluster-by-period model was sufficient to provide valid statistical inference. With the Satterthwaite degrees of freedom approximation, among the five RVEs we investigated, CR3 (a small-sample corrected RVE that approximates the leave-one-cluster-out jackknife variance estimator) consistently gave the best coverage results, even though it might be slightly anti-conservative when the number of clusters was below sixteen.

ELEANOR PULLENAYEGUM, The Hospital for Sick Children
[Sunday June 4 / dimanche 4 juin, 16:10 – STEM 364]
A proposed workflow for handling longitudinal data with irregular assessment times

Studies with longitudinal data often feature irregular observation times ; a common cause of this is that data are collected as part of usual societal operations rather than for the purposes of research. For example, electronic health records (EHRs) are often used to study disease processes over time, or the impact of treatment on disease trajectory. When the assessment times and the outcome process are independent, failure to account for the assessment times will result in biased inferences ; for example, if sicker patients visit more often, we will overestimate the burden of disease.

Although a very similar problem to missing data, the problem of irregular observation is typically ignored. When handling missing data, researchers know they need to report how much data is missing, consider the missingness mechanism, use an analytic approach suitable for their hypothesized missingness mechanism, and conduct sensitivity analysis. In this talk I will describe the irregular observation counterparts to these steps, outlining both the methods and procedures for implementing them in standard statistical software.

GRACE YI, University of Western Ontario
[Sunday June 4 / dimanche 4 juin, 15:35 – STEM 364]
Graphical proportional hazards measurement error models

In survival data analysis, the Cox proportional hazards (PH) model is perhaps the most widely used model to feature the dependence of survival times on covariates. While many inference methods have been developed under such a model or its variants, those models are not adequate for handling data with complex structured covariates. High-dimensional survival data often entail several features: (1) many covariates are inactive in explaining the survival information, (2) active covariates are associated in a network structure, and (3) some covariates are error-contaminated. To handle such kinds of survival data, we propose graphical PH measurement error models and develop inferential procedures for the parameters of interest. Our proposed models significantly enlarge the scope of the usual Cox PH model and have great flexibility in characterizing survival data. Theoretical results are established to justify the proposed methods. Numerical studies are conducted to assess the performance of the proposed methods.

C*-algebras and applications
Les C*-algèbres et leurs applications

Org: Thierry Giordano (University of Ottawa), **Dolapo Oyetunbi** (University of Ottawa), **Pawel Sarkowicz** (University of Ottawa) and/et **Charles Starling** (Carleton)

This session aims to connect researchers in all aspects of C*-algebra theory, from those working on C*-algebras built from dynamical or algebraic data (e.g. C*-algebras built from groups, group actions, semigroups, groupoids, and so on) to classification problems.

Cette session vise à mettre en relation les chercheurs dans tous les aspects de la théorie des C*-algèbres, depuis ceux qui travaillent sur les C*-algèbres construites à partir de données dynamiques ou algébriques (par exemple les C*-algèbres construites à partir de groupes, d'actions de groupes, de semigroupes, de groupoïdes, et ainsi de suite) jusqu'aux problèmes de classification.

Schedule/Horaire **Room/Salle: LMX 219**

Saturday June 3 **samedi 3 juin**

8:00 - 8:30	George Elliott (Toronto), *A generalization of AF algebras* (p. 61)
8:30 - 9:00	Magdalena Georgescu, *Cuntz-Pimsner algebras arising from C^*-correspondences over commutative C^*-algebras* (p. 62)
9:00 - 9:30	Robin Deeley (CU Boulder), *Solenoids and their C*-algebras* (p. 61)
9:30 - 10:00	Pawel Sarkowicz (Ottawa), *Polar decomposition in algebraic K-theory* (p. 63)
10:00 - 10:30	Boyu Li (Windsor/New Mexico State), *Examples of self-similar actions and imprimitivity theorems* (p. 62)
15:00 - 15:30	Jamie Mingo (Queen's), *Infinitesimal Freeness* (p. 63)
15:30 - 16:00	Adam Humeniuk (MacEwan), *The lattice of C*-covers of an operator algebra.* (p. 62)
16:00 - 16:30	Cristian Ivanescu (MacEwan), *Notes on Villadsen algebras* (p. 62)
16:30 - 17:00	Andrew Dean (Lakehead), *Structure and classification of real C^*-algebras* (p. 61)

Abstracts/Résumés

ANDREW DEAN, Lakehead University
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 219]
Structure and classification of real C^*-algebras

We shall survey classification results for real C^*-algebras and discuss the question of what stable ranks the various real forms of a C^*-algebra can have.

ROBIN DEELEY, University of Colorado
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 219]
Solenoids and their C-algebras*

Given a map $g : Y \to Y$ that is continuous and onto, one can construct a solenoid, which is the stationary inverse limit associated to g. This process leads to a space X and a homeomorphism $\varphi : X \to X$. The dynamics of g and φ are very much related. I will discuss various examples of this process and the C*-algebras associated with solenoids. In particular, we will see examples where Y is non-Hausdorff, but the associated solenoid X is Hausdorff.

GEORGE ELLIOTT, University of Toronto
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 219]
A generalization of AF algebras

A classification is given (in collaboration with Yasuhiko Sato) of a class of non-simple C*-algebras properly containing the class of AF algebras. It consists of those C*-algebras the tensor product of which with every (infinite-dimensional) Glimm UHF algebra is AF. Strictly speaking, the type I algebras with this property are not included, although these are necessarily even AF. The reason is that, for technical reasons, one must restrict to Jiang-Su stable C*-algebras (those absorbing tensorially the Jiang-Su C*-algebra)—although this property may hold automatically if there are no type I subquotients. The invariant, in the unital case, is exactly the same as for AF algebras.

MAGDALENA GEORGESCU, n/a
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 219]
Cuntz-Pimsner algebras arising from C-correspondences over commutative C*-algebras*

The Cuntz-Pimsner algebra construction produces a C*-algebra from the data contained in a C*-correspondence. Many other constructions — for example, crossed products $C(X) \rtimes_\alpha \mathbb{Z}$ — can be viewed through a Cuntz-Pimsner lens. As such, results and approaches from crossed products can inform investigations of some Cuntz-Pimsner algebras. In this talk, we will concentrate on C*-algebras arising from C*-correspondences over commutative algebras $C(X)$.

Specifically, consider X an infinite compact metric space, $\mathcal{V}$ a locally trivial vector bundle over X and $\alpha : X \to X$ a homeomorphism (often assumed minimal). We can construct a C*-correspondence $\mathcal{E}$ over $C(X)$ from the module of sections of $\mathcal{V}$, where we use the homeomorphism α to twist the left multiplication. As we shall see, many tractable and interesting C*-correspondences over $C(X)$ do in fact arise in this manner.

In this talk, I will discuss some of the structural properties and classification of the resulting Cuntz-Pimsner algebra $\mathcal{O}(\mathcal{E})$. Under the additional assumption that $\mathcal{V}$ is a line bundle the Cuntz-Pimsner algebra is a generalized crossed product, suggesting additional means of investigation. For Cuntz-Pimsner algebras arising from line bundles we can construct orbit-breaking subalgebras of $\mathcal{O}(\mathcal{E})$ and show that they are centrally large in the sense of Phillips.

This is based on joint work with Maria Stella Adamo, Dawn Archey, Marzieh Forough, Ja A Jeong, Karen Strung and Maria Grazia Viola.

ADAM HUMENIUK, MacEwan University
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 219]
The lattice of C-covers of an operator algebra.*

Every non-selfadjoint operator algebra A generates a C*-algebra, but isomorphic copies of A can generate many non-isomorphic C*-algebras, and we call these the C*-covers of A. A celebrated result–first proved by Hamana, is that a unique minimum C*-cover for any A exists, called the C*-envelope. The C*-envelope is intrinsic to A, but non-isomorphic operator algebras A and B can share the same C*-envelope. If we instead ask that A and B share ALL the same C*-covers, must A and B be isomorphic ?

There are multiple natural senses in which two operator algebras may have "the same" C*-covers, and we will discuss how these different senses remember different information about the operator algebras involved. Along the way, we will see how to construct a simple operator algebra that is not similar to a C*-algebra. This is joint work with Dr. Christopher Ramsey.

CRISTIAN IVANESCU, MacEwan University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 219]
Notes on Villadsen algebras

Using Villadsen construction, we construct an idempotent C*-algebra under the tensor product. This idempotent algebra is not strongly self-absorbing in the sense defined by Toms and Winter. However, the algebra we constructed does have the homotopic flip property. Some other properties of these idempotent Villadsen algebras will also be presented. This is joint work with Dan Kucerovsky from UNB.

C*-algebras and applications
Les C*-algèbres et leurs applications

BOYU LI, New Mexico State University
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 219]
Examples of self-similar actions and imprimitivity theorems

We introduce the notion of self-similar actions between groupoids, which leads to an imprimitivity theorem arising from these actions. This generalizes the many imprimitivity theorems arising from groupoid actions. We then apply our result to a special class of rank-2 graphs.

JAMIE MINGO, Queen's University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 219]
Infinitesimal Freeness

Infinitesimal freeness is an important tool for analysizing spike models in random matrix theory. However, independent copies of many of the standard ensembles in random matrix theory do not exhibit this property. On the other hand universal rules do exist. In this talk I will report on some recent progress with Guillaume Cébron which gives a new kind of free independence in the case of orthogonally invariant matrices.

PAWEL SARKOWICZ, University of Ottawa
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 219]
Polar decomposition in algebraic K-theory

We discuss how polar decomposition gives a natural relationship between the (Hausdorffized) algebraic K_1 group and the (Hausdorffized) unitary algebraic K_1 group for a unital C*-algebra, where one must account for positive elements in terms of tracial information.

Combined Games Session
Théorie des jeux combinatoires

Org: Melissa Huggan (Vancouver Island University), **Rebecca Milley** (Memorial University), **Mehdi Salimi** (St. Francis Xavier University) and/et **Alexandra Wesolek** (Simon Fraser University)

This session will examine aspects of Combinatorial Game Theory and Pursuit-Evasion Games research.

Combinatorial Game Theory is the study of two-player games with perfect information and no chance. It is an active research area intersecting combinatorics, algebra, and theoretical computer science.

A pursuit-evasion game is about how to guide one or a group of pursuers to catch one or a group of moving evaders. The geometric formulation of the pursuit-evasion game is called continuous pursuit-evasion, while the graph formulation is called discrete pursuit-evasion or graph searching. One of the goals of their study is to find the winning strategies of the players as well as the optimal number of players to win the game.

The main goal of this session is to bring together researchers in combinatorial game theory and continuous and discrete versions of pursuit-evasion games to disseminate their latest work. Applications to speak by all researchers welcome. This session may be accessible to undergraduate students.

Cette session examinera les aspects de la recherche sur la théorie des jeux combinatoires et les jeux de poursuite-évasion.

La théorie des jeux combinatoires est l'étude des jeux à deux joueurs avec une information parfaite et sans hasard. Il s'agit d'un domaine de recherche actif qui recoupe la combinatoire, l'algèbre et l'informatique théorique.

Un jeu de poursuite-évasion consiste à guider un ou plusieurs poursuivants pour attraper un ou plusieurs évadés en mouvement. La formulation géométrique du jeu de poursuite-évasion est appelée poursuite-évasion continue, tandis que la formulation graphique est appelée poursuite-évasion discrète ou recherche de graphe. L'un des objectifs de leur étude est de trouver les stratégies gagnantes des joueurs ainsi que le nombre optimal de joueurs pour gagner le jeu.

L'objectif principal de cette session est de réunir des chercheurs en théorie combinatoire des jeux et en versions continues et discrètes des jeux de poursuite-évasion afin de diffuser leurs derniers travaux. Tout chercheur est invité à soumettre une proposition pour participer dans la session. Cette session peut être accessible aux étudiants de premier cycle.

Schedule/Horaire — Room/Salle: CRXC 407

Saturday June 3 — samedi 3 juin

8:00 - 8:30	Melissa Huggan (Vancouver Island University), *The damage number of the product of graphs* (p. 66)
8:30 - 9:00	Rylo Ashmore (Memorial University), *Herding cats stuck in trees* (p. 65)
9:00 - 9:30	Anthony Bonato (Toronto Metropolitan University), *The Localization Game* (p. 65)
9:30 - 10:00	Trent Marbach (Toronto Metropolitan University), *The one-visibility localization game* (p. 67)
10:00 - 10:30	Danny Dyer (Memorial University of Newfoundland), *The cheating robot on graph products* (p. 65)
15:00 - 15:30	Rebecca Milley (Memorial University of Newfoundland - Grenfell Campus), *Progress on misère dicots* (p. 67)
15:30 - 16:00	Alfie Davies (Memorial University of Newfoundland), *Atomic structure and the multiverse* (p. 65)
16:00 - 16:30	Alex Clow (Simon Fraser University), *An Alternate Construction of Numbers as Games* (p. 65)
16:30 - 17:00	Thomas Wolf (Brock University), *Families of P-Positions in Chomp* (p. 68)
17:00 - 17:30	Svenja Huntemann (Concordia University of Edmonton), *Temperature of Partizan ArcKayles* (p. 66)

Sunday June 4 — dimanche 4 juin

8:30 - 9:00	Mehdi Salimi (St. Francis Xavier University), *The Strategies for Players to Win in Pursuit-Evasion Differential Games with Various Constraints* (p. 67)
9:00 - 9:30	Brett Stevens (Carleton University), *Proving simple things about one dimensional snort* (p. 68)
9:30 - 10:00	Dylan Pearson (Mount Allison University), *Slow Localization* (p. 67)
10:00 - 10:30	Mary Rose Jerade (University of Ottawa), *So Long Sucker: 2-player, 2-color case* (p. 66)

Combined Games Session
Théorie des jeux combinatoires

Abstracts/Résumés

RYLO ASHMORE, Memorial University of Newfoundland
[Saturday June 3 / samedi 3 juin, 8:30 – CRXC 407]
Herding cats stuck in trees

In the game of Cat Herding on a graph, one player (the herder) will omnipresently delete edges, while the other player (the cat) is on a vertex of the graph, and will move along any path to a new vertex. Eventually, the cat is isolated on a single vertex, and the cat's objective is to delay this event, while the herder tries to hasten it. In an optimally played game, the number of cuts the herder made to isolate the cat is the *cat number* of the graph.

In this talk, we will investigate this graph parameter for both dense and sparse graphs. We will see an argument that the asymptotic behaviour of the cat number of complete graphs is $\frac{n^2}{3}$. We also look at an unexpected connection between cat herding on trees and Fibonacci numbers. In particular, we will see that trees with maximum cat number amongst graphs with n vertices have cat number asymptotically $\log_\phi n$.

ANTHONY BONATO, Toronto Metropolitan University
[Saturday June 3 / samedi 3 juin, 9:00 – CRXC 407]
The Localization Game

The Localization game models an invisible evader on a graph detectable by distance probes. The game and its corresponding optimization parameter, the localization number, have come into a renewed focus in recent years. We give a sample of recent results on the localization number for various graph families, ranging from locally finite graphs, directed graphs, and graphs arising from designs and Latin squares.

ALEX CLOW, Simon Fraser University
[Saturday June 3 / samedi 3 juin, 16:00 – CRXC 407]
An Alternate Construction of Numbers as Games

The standard way to construct numbers in a combinatorial game ruleset is as strings in Blue-Red Hackenbush, which is equivalent to an ordinal sum with positive and negative integer summands. We provide another method of constructing all numbers as an ordinal sum in a natural rule set. Unlike in Hackenbush, our method constructs every $x \geq 0$ with only non-negative integer summands. In doing so we explore some novel results regarding ordinal sums of numbers which have broader implications to games with number valued positions.

Joint work with Neil McKay (University of New Brunswick St.John).

ALFIE DAVIES, Memorial University of Newfoundland
[Saturday June 3 / samedi 3 juin, 15:30 – CRXC 407]
Atomic structure and the multiverse

Losing games has proved far more difficult than winning. However, the complexities of misère play are not quite as impenetrable as was once feared decades ago. Recent work has directed attention towards the study of what is called a universe; a set of games exhibiting various closure properties. Dead-ending universes are particularly amenable to analysis, and we present related results on the structure of the monoid of Left dead-ends. We also discuss constructions of the universal closures of some well-known rulesets, including Domineering and Hackenbush.

Combined Games Session
Théorie des jeux combinatoires

DANNY DYER, Memorial University of Newfoundland
[Saturday June 3 / samedi 3 juin, 10:00 – CRXC 407]
The cheating robot on graph products

In this talk, we will explore recent results on the cheating robot version of the game of cops and robbers. In this version, the robber may "cheat" and move away once a cop has begun their move to capture them. We will investigate some results involving bounds on the cheating robot number of planar graphs and the the cheating robot number of graph products. Joint work with Nancy Clarke and William Kellough.

MELISSA HUGGAN, Vancouver Island University
[Saturday June 3 / samedi 3 juin, 8:00 – CRXC 407]
The damage number of the product of graphs

In adversarial situations on networks, we often concern ourselves with minimizing resources required for neutralizing a threat. Here we consider a different parameter which addresses the situation where an adversary is damaging each unique location they visit. Framed within the context of the game of Cops and Robbers on graphs, the robber tries to maximize the number of unique vertices they visit to maximize the damage to the graph, while the cops aim to minimize the damage by limiting the robber territory. This model was first introduced in 2019 by Cox and Sanaei. We build on their results. We provide a general upper bound for the damage number of the Cartesian product of graphs and consider the damage number of the product of two trees or cycles. We also consider graphs with small damage number along with their products.

This is joint work with Margaret-Ellen Messinger and Amanda Porter.

SVENJA HUNTEMANN, Concordia University of Edmonton
[Saturday June 3 / samedi 3 juin, 17:00 – CRXC 407]
Temperature of Partizan ArcKayles

Partizan ArcKayles is played on any finite graph whose edges have been coloured blue or red. The player called Left removes any blue edge and any incident edges, while the player Right removes any red and incident edges. This game is a generalization of Domineering, which has been conjectured to have a maximum temperature of 2. We will discuss the temperature of Partizan ArcKayles, focusing on trees.

This is joint work with Neil McKay (University of New Brunswick) and Craig Tennenhouse (University of New England).

MARY ROSE JERADE, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 10:00 – CRXC 407]
So Long Sucker: 2-player, 2-color case

So Long Sucker is a 1950 strategy board game developed by mathematician John Forbes Nash Jr. and his colleagues. It has a simple layout consisting of 4 players with k chips each of their designated color, and a board consisting of r empty rows. With a clear setup comes intricate rules that allow the game to reflect real life negotiations and conflicts between multiple parties. It is a useful tool to study players' behaviors in situations that involve individual and group decisions.

The set of rules is very distinctive: players take turns but not in a fixed order, agreements can be made and broken at any time, and a player can win the game even if they are out of chips. One of the main points of interest in studying this game, is to study when a player has a winning strategy.

The game starts off with four players that get eliminated one after the other until only the winner is left. Thus in order to study winning strategies, it is of interest to look at endgame situations ; particularly when there are only two players left in the game. During this talk, we will present a particular setup of the game: there are two players, first player Blue and second

player Red, and their respective colors left in play. We will show through inductive reasoning, how we are able to characterize Blue's winning strategies.

TRENT MARBACH, Toronto Metropolitan University
[Saturday June 3 / samedi 3 juin, 9:30 – CRXC 407]
The one-visibility localization game

We introduce a variant of the localization game in which the cops only have visibility one, along with the corresponding optimization parameter, the one-visibility localization number ζ_1. This parameter has some surprising connections to the isoperimetric inequalities, and to the reduced visibility cops and robber game. We explore these connections by studying upper and lower bounds for ζ_1 on k-ary trees and on Cartesian grids. We will also present the connections we have found to some other graph properties, such as tree-width and domination number.

REBECCA MILLEY, Grenfell Campus, Memorial University of NL
[Saturday June 3 / samedi 3 juin, 15:00 – CRXC 407]
Progress on misère dicots

The algebraic structure of misère-play games, where the last move loses, is much less understood than that of normal-play, where the last move wins. Full misère has less equality and comparability, no nonzero inverses, and a trivial equivalence class for zero ; however, restricting to certain subsets of misère games has proven useful for misère analysis. This talk will survey progress in the study of "dicot" games, where at every point, either both players have a legal move or neither does. We review the recent developments of a recursive comparison test, unique canonical forms, and classification of invertible elements, before outlining the next direction of open problems for the dicot universe.

DYLAN PEARSON, Mount Allison University
[Sunday June 4 / dimanche 4 juin, 9:30 – CRXC 407]
Slow Localization

A variation of the localization game is studied where the cops are restricted to moving to adjacent vertices on their turn. The distance from each cop to the robber is returned every round with the cops' goal being to uniquely identify the robber's location. The minimum number of cops required to locate the robber is called the slow localization number. We compare the slow localization number with the localization number on different graph classes and determine the slow localization number on Cartesian grids, caterpillars, wheels and cocoons.

This is joint work with Danny Dyer and Melissa Huggan.

MEHDI SALIMI, St. Francis Xavier University
[Sunday June 4 / dimanche 4 juin, 8:30 – CRXC 407]
The Strategies for Players to Win in Pursuit-Evasion Differential Games with Various Constraints

Pursuit-evasion differential games have garnered substantial scholarly attention, exemplified by significant contributions such as Leon A. Petrosyan's seminal work, "Differential Pursuit Games" (1977).

This study delves into a pursuit-evasion differential game involving an infinite number of pursuers and a lone evader. Notably, the control functions employed by all participants must conform to either geometric or integral constraints. By formulating winning strategies, the pursuers can effectively apprehend the evader by ensuring that at least one pursuer achieves an identical geometric position.

The study presents a comprehensive strategy enabling pursuers to capture the evader successfully. Moreover, the research findings have practical implications across diverse domains, particularly robotics and mobile gaming. The insights from this

investigation contribute to the advancement of sophisticated robotic systems and foster the enhancement of interactive experiences within mobile gaming applications.

BRETT STEVENS, Carleton University
[Sunday June 4 / dimanche 4 juin, 9:00 – CRXC 407]
Proving simple things about one dimensional snort

Winning Ways volume 1 proposes values, modulo infinitesimal closeness, for one dimensional snort positions when they are cooled by 1. It also claims that these values are themselves infinitesimally close to the overheated values of sums of simple numbers and *s. We set out to articulate proofs of these assertions and further to determine and prove the temperatures and other cooled values of one dimensional snort positions. We were successful at establishing and proving cooled values. Although we believe we know the temperatures of these games, completing the proof has been challenging. I will discuss our successes and challenges as wells as describing a 1-d snort playing bot we have made available on the internet.

THOMAS WOLF, Brock University
[Saturday June 3 / samedi 3 juin, 16:30 – CRXC 407]
Families of P-Positions in Chomp

The main part of the talk describes a method for finding families of P-positions which let to five 2-parameter families describing all P-positions with tiles in two rows and one column. Comments will also be made on a collection of all loosing (P-) positions up to some size, a conjecture about the asymptodic density of P-positions, a computation determining Sprague-Grundy (SG) numbers and a formula for SG numbers for any position with tiles in two rows.

Computational Aspects in Low-Dimensional Topology and Contact Geometry
Aspects computationnels de la topologie de basse dimension et de la géométrie de contact

Org: Maia Fraser (University of Ottawa), **Emmy Murphy** (Princeton University) and/et **Michael Wong** (University of Ottawa)

Recent advances in computational techniques have allowed us to take better advantage of various powerful theoretical machineries in low-dimensional topology (LDT) and contact geometry, including (but not limited to) knot and manifold invariants. A main goal of this session is to bring together researchers to further develop these computational methods. The session also aims to foster interactions between the LDT community, the contact and symplectic geometry community, and the machine learning (ML) community, to explore the interface among these disciplines, for example the potential to harness the power of ML to predict properties of topological objects that are otherwise difficult to determine.

Les progrès récents dans les techniques de calcul nous ont permis de mieux tirer parti de divers mécanismes théoriques puissants en topologie de basse dimension ("LDT") et en géométrie de contact, y compris (mais sans s'y limiter) les invariants de nœuds et de variétés. L'un des principaux objectifs de cette session est de réunir des chercheurs pour développer davantage ces méthodes de calcul. La session vise également à encourager les interactions entre la communauté LDT, la communauté de la géométrie de contact et symplectique, et la communauté de l'apprentissage automatique (ML), afin d'explorer l'interface entre ces disciplines, par exemple la possibilité d'exploiter la puissance du ML pour prédire les propriétés des objets topologiques qui sont autrement difficiles à déterminer.

Schedule/Horaire — Room/Salle: LMX 407

Saturday June 3 — samedi 3 juin

15:00 - 15:30	Misha Tyomkin (Dartmouth), *On numbers associated with a strong Morse function* (p. 71)
15:30 - 16:00	Homayun Karimi (McMaster), *Mock Seifert matrices and unoriented algebraic concordance* (p. 70)
16:00 - 16:30	Zachary Winkeler (Smith), *Spectral sequence computations in knot Floer homology* (p. 71)
16:30 - 17:00	Jie Chen (McMaster), *The concordance group of flat knots* (p. 70)
17:00 - 17:30	Agnese Barbensi (Melbourne), *Hypergraphs for multiscale cycles in structured data* (p. 70)
17:30 - 18:00	Daniele Celoria (Melbourne), *GridPyM: a Python module to handle grid diagrams* (p. 70)

Sunday June 4 — dimanche 4 juin

9:00 - 9:30	Dror Bar-Natan (Toronto), *Computing the Zombian of an Unfinished Columbarium* (p. 69)
9:30 - 10:20	James Halverson (Northeastern) (p. 70)
15:00 - 15:50	András Juhász (Oxford), *The unknotting number, hard unknot diagrams, and Reinforcement Learning* (p. 70)
16:00 - 16:30	Thomas Wolf (Brock), *TurboKnots* (p. 71)
16:30 - 17:00	Patricia Sorya (UQAM), *Characterizing slopes: explicit bounds for satellite knots* (p. 71)

Abstracts/Résumés

DROR BAR-NATAN, University of Toronto, Mathematics
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 407]
Computing the Zombian of an Unfinished Columbarium

The zombies need to compute a quantity, the zombian, that pertains to some structure - say, a columbarium. But unfortunately (for them), a part of that structure will only be known in the future. What can they compute today with the parts they already have to hasten tomorrow's computation ?

That's a common quest, and I will illustrate it with a few examples from knot theory and with two examples about matrices - determinants and signatures. I will also mention two of my dreams (perhaps delusions): that one day I will be able to reproduce, and extend, the Rolfsen table of knots using code of the highest level of beauty.

See also http://drorbn.net/ott23.

AGNESE BARBENSI, University of Melbourne
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 407]
Hypergraphs for multiscale cycles in structured data

In this talk we will explore techniques to include homology generators in the persistent homology pipeline, and we will see how these can be used to infer geometric and structural information on the underlying system, with a focus on spatial curves and biological applications.

DANIELE CELORIA, University of Melbourne
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 407]
GridPyM: a Python module to handle grid diagrams

Grid diagrams are a combinatorial version of classical link diagrams, widely used in theoretical, computational and applied knot theory. Motivated by questions from (bio)-physical knot theory, we introduce GridPyM, a Sage compatible Python module that handles grid diagrams. GridPyM focuses on generating and simplifying grids, and on modelling local transformations between them.

JIE CHEN, McMaster University
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 407]
The concordance group of flat knots

Virtual knots were introduced by Kauffman, and they represent knots in thickened surfaces up to stable equivalence. Each virtual knot determines a flat knot, which is the homotopy class of the immersed curve in the surface. Turaev raised a list of questions regarding sliceness of flat knots and concordance classes of long flat knots in 2004. I will talk about my work on the concordance group of flat knots based on calculated results in FlatKnotInfo and conjectures suggested by the tabulation.

JAMES HALVERSON, Northeastern
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 407]

ANDRÁS JUHÁSZ, Oxford
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 407]
The unknotting number, hard unknot diagrams, and Reinforcement Learning

We have developed a Reinforcement Learning agent based on the IMPALA architecture that often finds minimal unknotting trajectories for a knot diagram up to 200 crossings. We have used this to determine the unknotting number of 57k knots. We then took diagrams of connected sums of such knots with oppositely signed signatures, where the summands were overlaid. The agent has found unknotting trajectories involving several crossing changes that result in hyperbolic knots. Based on this, we have shown that, given knots K and K' that are not 2-bridge, there is a diagram of their connected sum and u(K) + u(K') unknotting crossings such that changing any one of them results in a prime knot. As a by-product, we have obtained a dataset of 2.6 million distinct hard unknot diagrams ; most of them under 35 crossings. Assuming the additivity of the unknotting number, we can determine the unknotting number of 43 at most 12-crossing knots for which the unknotting number is unknown. This is joint work with Taylor Applebaum, Sam Blackwell, Alex Davies, Thomas Edlich, and Marc Lackenby.

Computational Aspects in Low-Dimensional Topology and Contact Geometry
Aspects computationnels de la topologie de basse dimension et de la géométrie de contact

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HOMAYUN KARIMI, McMaster University
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 407]
Mock Seifert matrices and unoriented algebraic concordance

In this talk, we describe the concordance properties of signature and determinant invariants for knots in thickened surfaces. If $K \subset \Sigma \times I$ is $\mathbb{Z}/2$ null-homologous and slice, we show that its signatures vanish and its determinants are perfect squares. A mock Seifert matrix is an integral square matrix representing the Gordon-Litherland form of a pair (K, F), where K is a knot in a thickened surface and F is an unoriented spanning surface for K. Using these matrices, we introduce a new notion of unoriented algebraic concordance, as well as a new group denoted $m\mathcal{G}^{\mathbb{Z}}$ and called the unoriented algebraic concordance group. This group is abelian and infinitely generated. Mock Seifert matrices can also be used to define new invariants, such as the mock Alexander polynomial and mock Levine-Tristram signatures. These invariants are applied to questions about virtual knot concordance, crosscap numbers, and Seifert genus for knots in thickened surfaces. This talk is based on joint works with Hans U. Boden.

PATRICIA SORYA, Université du Québec à Montréal (UQÀM)
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 407]
Characterizing slopes: explicit bounds for satellite knots

A slope p/q is said to be characterizing for a knot if the homeomorphism type of its p/q-Dehn surgery determines the knot up to isotopy. The existence of a lower bound for $|q|$ that guarantees p/q is characterizing for a given knot has been established in recent work. I am currently collaborating with Laura Wakelin to determine this bound explicitly for an infinite family of satellite knots.

MISHA TYOMKIN, Dartmouth College
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 407]
On numbers associated with a strong Morse function

Morse function on a manifold M is called strong if all its critical points have different critical values. Given a strong Morse function f and a field $\mathbb{F}$ we construct a bunch of elements of $\mathbb{F}$, which we call Bruhat numbers (they're defined up to sign). More concretely, Bruhat number is written on each bar in the barcode of f (a.k.a. Barannikov decomposition). It turns out that if homology of M over F is that of a sphere, then the product of all the numbers is independent of f. We then construct the barcode and Bruhat numbers with twisted (a.k.a. local) coefficients and prove that the mentioned product equals the Reidemeister torsion of M. In particular, it's again independent of f. This way we link Morse theory to the Reidemeister torsion via barcodes. Time permitting, we will also discuss how parametric Morse theory comes into play. Based on a joint work with Petya Pushkar.

ZACHARY WINKELER, Smith College
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 407]
Spectral sequence computations in knot Floer homology

A defining feature of the knot Floer homology of a knot $K \subset S^3$ is the spectral sequence converging to the Heegaard Floer homology of S^3. By studying the behavior of the Legendrian invariants $\lambda^{\pm}$ under this spectral sequence, we can obstruct the existence of decomposable Lagrangian cobordisms between Legendrian knots. I will talk about recent work in this direction, including computational aspects and potential applications of similar ideas to other spectral sequences.

This talk is based on joint work with Mitchell Jubeir, Ina Petkova, Noah Schwartz, and C.-M. Michael Wong.

Computational Aspects in Low-Dimensional Topology and Contact Geometry
Aspects computationnels de la topologie de basse dimension et de la géométrie de contact

THOMAS WOLF, Brock University
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 407]
TurboKnots

The package TurboKnots started as a tool box for working with knot diagrams to generate random knots, simplify diagrams by performing 'beneficial' Reidemeister moves, extracting prime knots that may overlap, performing flype moves and pass moves that reduce or preserve the number of crossings and by compactifying diagrams. Knots with up to 15 crossings can be identified instantly. The talk will mention coloring and unknotting computations of all knots with up to 15 crossings and comment on the efficiency of its HOMFLYPT polynomial computations.

Design theory and graph decomposition
Théorie des plans et de la décomposition des graphes

Org: Andrea Burgess (University of New Brunswick), **Peter Danziger** (Toronto Metropolitan University) and/et **Alice Lacaze-Masmonteil** (University of Ottawa)

In 1850, Reverend Kirkman proposed the following problem. Fif- teen children are to walk to school three abreast and once a day for seven days. Can they be arranged so that no two shall walk abreast twice ? Known as the Kirkman's schoolgirl problem, this problem is one of the first scheduling problem solved as a design theoretic problem and as a cycle decomposition problem. Since Reverend Kirkman proposed this famous problem, design theory and cycle decomposition have grown into rich and vibrant areas of combinatorics. The purpose of this session is to showcase recent results on topics such as games on designs, cycle decomposition of graphs and directed graphs, path decomposition of graphs and directed graphs, coloring of cycle systems, triple systems, covering arrays, latin squares and other topics in design theory and graph decomposition.

En 1850, le révérend Kirkman propose le problème suivant. Quinze enfants doivent aller à l'école à pied, trois de front et une fois par jour, pendant sept jours. Peut-on s'arranger pour que deux d'entre eux ne marchent pas deux fois de front ? Connu sous le nom de problème de l'écolière de Kirkman, ce problème est l'un des premiers problèmes d'ordonnancement résolus en tant que problème théorique de conception et en tant que problème de décomposition de cycle. Depuis que le révérend Kirkman a proposé ce célèbre problème, la théorie de la conception et la décomposition des cycles sont devenues des domaines riches et dynamiques de la combinatoire. L'objectif de cette session est de présenter les résultats récents sur des sujets tels que les jeux sur les plans, la décomposition des cycles des graphes et des graphes dirigés, la décomposition des chemins des graphes et des graphes dirigés, la coloration des systèmes de cycles, les systèmes triples, les tableaux de recouvrement, les carrés latins et d'autres sujets de la théorie des plans et de la décomposition des graphes.

Schedule/Horaire — Room/Salle: STEM 664

Saturday June 3 — samedi 3 juin

15:00 - 15:30	Brett Stevens (Carleton University), *Non-linearly parameterized pencils of conics in even projective planes* (p. 75)
15:30 - 16:00	Mateja Sajna (University of Ottawa), *On the directed Oberwolfach problem for complete symmetric equipartite digraphs* (p. 75)
16:00 - 16:30	Alice Lacaze-Masmonteil (University of Ottawa), *Resolution of the directed Oberwolfach problem with cycles of equal length* (p. 74)
16:30 - 17:00	Masoomeh Akbari (University of Ottawa), *On the Generalized Honeymoon Oberwolfach Problem* (p. 73)
17:00 - 17:30	Lucia Moura (University of Ottawa), *Hypergraph-dependent Covering Arrays* (p. 74)
17:30 - 18:00	Muhammad Tariq Javed (Toronto Metropolitan University), *Sequence Covering and Packing Arrays* (p. 74)

Sunday June 4 — dimanche 4 juin

9:00 - 9:30	Tommaso Traetta (Università di Brescia), *Generalized Heffter arrays and near alternating sign matrices* (p. 76)
9:30 - 10:00	Alyssa Sankey (University of New Brunswick), *A family of regular weights on the folded Johnson scheme J(2n,n)* (p. 75)
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Abstracts/Résumés

MASOOMEH AKBARI, University of Ottawa
[Saturday June 3 / samedi 3 juin, 16:30 – STEM 664]
On the Generalized Honeymoon Oberwolfach Problem

Design theory and graph decomposition
Théorie des plans et de la décomposition des graphes

The Honeymoon Oberwolfach Problem (HOP) is one of the recent and interesting variations of the Oberwolfach Problem (OP). This problem was introduced by Sajna in 2019, and formulated as follows. We wish to make a seating arrangement for $2n$ participants consisting of n newlywed couples in a room with t round tables that, respectively, seat $2m_1, \ldots, 2m_t$ people so that all tables are full at each meal, that is, $2m_1 + 2m_2 + \ldots + 2m_t = 2n$, and each participant sits next to their spouse every time and next to each other participant exactly once. In graph theory, a solution to HOP is equivalent to a decomposition of $K_{2n} + (2n-3)I$, the complete graph on $2n$ vertices plus $2n-3$ additional copies of a 1-factor I, into 2-factors, each consisting of disjoint I-alternating cycles of lengths $2m_1, \ldots, 2m_t$. A number of cases of HOP have already been solved by Lepine and Sajna ; most notably, the case of uniform cycle lengths.

So far, HOP has been defined with the constraint that each table size is at least four. In this talk, I generalize the problem to allow for tables of size two. A solution to the generalized HOP with s tables of size 2 and t round tables of sizes $2m_1, 2m_2, \ldots, 2m_t$ is equivalent to a decomposition of the multigraph $K_{2n} + (\gamma - 1)I$, for an appropriate integer γ, into subgraphs consisting of disjoint I-alternating cycles of lengths $2m_1, 2m_2, \ldots, 2m_t$ and s copies of K_2. I will present a general approach to this problem, and recent solutions to several cases.

MUHAMMAD TARIQ JAVED, Toronto Metropolitan University
[Saturday June 3 / samedi 3 juin, 17:30 – STEM 664]
Sequence Covering and Packing Arrays

A Sequence Covering Array (SeqCA) or a Sequence Packing Array (SeqPA) is a set $\mathcal{B}$ of N k-sequences on v events, where $2 \leq k \leq v$. In a SeqCA (SeqPA), every pair of events appears in at least (most) one of the sequences in $\mathcal{B}$. The number of sequences in a minimum (maximum) size SeqCA (SeqPA) is called the SeqCA (SeqPA) number, denoted by k-SeqCAN(v) (k-SeqPAN(v)). In the literature, SeqCA (SeqPA) numbers are only known for small values of k, or for the case when $k = v$. For $N \in \{4, 5, 6, 7, 10, 11\}$, we determined the set of pairs $\{(v, k) : k\text{-SeqCAN}(v) = N\}$. For $N \in \{2, 3, 4, 5\}$, we determined the set of pairs $\{(v, k) : k\text{-SeqPAN}(v) = N\}$, and for $N \in \{7, 8, 9\}$ we determine the set $\{(v, k) : k\text{-SeqPAN}(v) \leq N\}$. For $N \in \{3, 4, 5, 6, 7, 8, 9\}$, known bounds on SeqPA numbers were improved.

ALICE LACAZE-MASMONTEIL, University of Ottawa
[Saturday June 3 / samedi 3 juin, 16:00 – STEM 664]
Resolution of the directed Oberwolfach problem with cycles of equal length

A $\vec{C}_m$-factor of a digraph is a spanning subdigraph comprised of disjoint directed cycles of length m and a $\vec{C}_m$-factorization is a decomposition into $\vec{C}_m$-factors. It has been conjectured that $K^*_{\alpha m}$ admits a $\vec{C}_m$-factorization if and only if $(\alpha, m) \notin \{(1, 4), (1, 6), (2, 3)\}$. This problem is known as the directed Oberwolfach problem with cycles of equal length. In this talk, we present a solution to the last outstanding case ; that is, we show that K^*_{2m} admits a $\vec{C}_m$-factorization for all odd $m \geqslant 11$.

LUCIA MOURA, University of Ottawa
[Saturday June 3 / samedi 3 juin, 17:00 – STEM 664]
Hypergraph-dependent Covering Arrays

In this talk, we discuss generalizations of cover-free families and covering arrays that use a hypergraph to specify coverage.

A d-CFF(t, n) is a $t \times n$ array such that for each subset of $d + 1$ columns, every possible weight-1 binary tuple occurs in at least one of the rows. CFFs are used in combinatorial group testing to determine up to d defective items in a collection of n items by pooling items to be tested together in t tests ; the defective items are deduced from the test results.

A covering array (CA) of size N, strength t, k factors and alphabet size v is an $N \times k$ array such that for each subset of t columns, every possible t-tuple of the alphabet occurs in at least one of the rows. CAs give effective test suits for software testing giving a good coverage of the parameter space.

Both types of array require that “coverage" must occur in every subset of columns of a fixed size. The number of rows/tests must be minimized and it grows as the logarithm of the number of columns. In the hypergraph-dependent versions of these problems,

edges of a hypergraph specify in which columns "coverage" is required. The hypergraph model for CAs has been studied since Meagher&Stevens (2005). The hypergraph model for CFFs was introduced by Idalino and Moura (IWOCA2022), motivated by applications in pandemic screening, where fewer tests are needed by using knowledge about connected communities.

We will overview known results and future work on hypergraph-dependent covering arrays.

AMIN SAEIDI, University of Limpopo

[Sunday June 4 / dimanche 4 juin, 10:00 – STEM 664]

Designs constructed from 2-transitive groups

In this talk, we will explore the Key-Moori Method, a powerful technique for constructing designs that are invariant under finite primitive groups, with a focus on 2-transitive groups. We will apply this method to several families of finite simple groups, as well as the affine group $AGL(n, q)$.

For an affine group G, we will demonstrate how the structure of the conjugacy classes of the general linear group $GL(n, q)$ can be used to obtain the parameters of the G-invariant designs constructed by this method, and we will explicitly compute the parameters for small values of n. We will also demonstrate how fixed-points of primitive groups can be used to find designs and obtain what we call "reduced designs" which enable us to determine the automorphism groups of the designs in many cases.

MATEJA SAJNA, University of Ottawa

[Saturday June 3 / samedi 3 juin, 15:30 – STEM 664]

On the directed Oberwolfach problem for complete symmetric equipartite digraphs

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 $t_1, t_2, \ldots, t_k$ for several meals so that each participant sits next to every other participant at exactly one meal, assuming that $t_1 + t_2 + \ldots + t_k = n$. 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 $t_1, t_2, \ldots, t_k$.

In this talk, we discuss the directed version for complete symmetric equipartite digraphs. Thus, we are interested in decomposing $K^*_{n[m]}$, the complete symmetric equipartite digraph with n parts of size m, into spanning subdigraphs, each a disjoint union of k directed cycles of lengths $t_1, t_2, \ldots, t_k$ (where $t_1 + t_2 + \ldots + t_k = mn$). Such a decomposition models a seating arrangement of mn participants, consisting of n delegations of m participants each, at k tables of sizes $t_1, t_2, \ldots, t_k$ so that each participant sits *to the right of each participant from a different delegation* exactly once. Recent solutions to extensive cases of this problem for uniform cycle lengths will be presented.

This is joint work with Nevena Francetić.

ALYSSA SANKEY, University of New Brunswick

[Sunday June 4 / dimanche 4 juin, 9:30 – STEM 664]

A family of regular weights on the folded Johnson scheme J(2n,n)

The Odd graph is a distance-regular graph that generates the Johnson J(2m+1,m) association scheme. Its vertices are the m-subsets of a $(2m + 1)$-set, and are adjacent if and only if disjoint. It is well known that the union of this graph and its distance 2 graph is isomorphic to a folded Johnson graph. In this talk we describe how the union of graphs extends to a fusion of the full association scheme. Using the fusion, we define a certain edge weight on the folded graph and obtain the scheme J(2m+2,m+1) as a double *covering configuration* of the folded graph.

This family of examples illustrates two concepts that we shall attempt to convince the audience are interesting: Firstly, an infinite family of regular weights with so-called *minimal closure* ; secondly the explicit covering schemes derived from these weights that coincide with the well known double covers of folded distance-regular graphs.

If time permits, we will show that the Hamming scheme H(n-1,2) lends itself to a similar construction involving the folded n-cube.

Design theory and graph decomposition
Théorie des plans et de la décomposition des graphes

BRETT STEVENS, Carleton University
[Saturday June 3 / samedi 3 juin, 15:00 – STEM 664]
Non-linearly parameterized pencils of conics in even projective planes

In a Desarguesian projective plane, the set of conics through three or four points form a linearly parameterized net of pencil of conics, respectively. In an odd plane, the set of conics tangent to three lines forms a dual net which might not be linearly parameterized. The subset of these through a fixed point is a non-linearly parameterized pencil. In even planes all the tangent lines of a conic intersect in a common point, the nucleus, so set of conics tangent to three lines is equivalent to the set of conics which share a common nucleus and the same construction is not possible. We show that there does exists non-linearly parameterized pencils of conics in even planes and explore their structure and combinatorics. We demonstrate a connection between these pencils and the construction of mutually orthogoval affine planes and covering arrays.

TOMMASO TRAETTA, Università degli Studi di Brescia
[Sunday June 4 / dimanche 4 juin, 9:00 – STEM 664]
Generalized Heffter arrays and near alternating sign matrices

In this talk, we present a generalization of Heffter arrays [1] by allowing that:

• the number of nonzero entries in each row (resp. column) of the array be not constant, and

• the entries of the array, *in absolute value*, belong to an arbitrarily chosen subset S of a group G, not necessarily abelian.

We show that *generalized Heffter arrays* (GHA) can be used to construct orthogonal path or cycle decompositions and biembeddings of Cayley graphs onto orientable surfaces. The structural properties of the latter depend on the sum of the entries in each row and column of the GHA (with respect to a given ordering). Preferable are those satisfying the further strong property of being *simple*: for each row and each column, the partial sums (of the non-zero entries) are pairwise distinct, and only the total sum is possibly zero. We show that simple GHAs over cyclic groups can be easily built by means of *near alternating sign matrices* [2]. Further results and future works will be discussed.

This is joint work with Lorenzo Mella.

References

[1] L. Mella and T. Traetta. *Constructing generalized Heffter arrays via near alternating sign matrices*, submitted.
[2] R.A. Brualdi and H.K. Kim. *A Generalization of Alternating Sign Matrices*, J. Combin. Des. 23 (2015), 204-215.

Early Career Research in Number Theory
Recherche en début de carrière en théorie des nombres

Org: Cédric Dion and/et **William Verreault** (Université Laval)

This session aims to shine a light on the work of graduate students, postdocs and early career professors working in number theory, to give them more exposure and a chance to exchange ideas. All contributions in elementary, analytic, and algebraic number theory will be considered.

Cette session vise à mettre en lumière le travail des étudiants diplômés, des post-docs et des professeurs en début de carrière travaillant dans le domaine de la théorie des nombres, afin de leur donner plus de visibilité et une chance d'échanger des idées. Toutes les contributions en théorie élémentaire, analytique et algébrique des nombres seront prises en considération.

Schedule/Horaire **Room/Salle: LMX 257**

Sunday June 4 — dimanche 4 juin

8:00 - 8:30	Samprit Ghosh (University of Toronto), *Higher Euler-Kronecker coefficients* (p. 79)
8:30 - 9:00	Shuyang Shen (University of Toronto), *On Irreducible Trinomials* (p. 81)
9:00 - 9:30	Jérémy Champagne (University of Waterloo), *Diophantine approximation by linear forms with angular restrictions* (p. 77)
9:30 - 10:00	Ting Han Huang (Concordia University), *Special values of triple product p-adic L-functions and p-adic Abel-Jacobi maps* (p. 79)
10:00 - 10:30	Tony Haddad (Université de Montréal), *A coupling for the prime factors of a random integer* (p. 79)
15:00 - 15:30	Jason Fang and Anton Mosunov (University of Waterloo), *A Lower Bound for the Area of the Fundamental Region of a Binary Form* (p. 78)
15:30 - 16:00	Matthew Sunohara (University of Toronto), *On stable transfer operators and functorial transfer kernels* (p. 81)
16:00 - 16:30	Valeriya Kovaleva (Université de Montréal), *Correlations of the Riemann Zeta on the critical line* (p. 80)
16:30 - 17:00	Matt Olechnowicz (University of Toronto), *Distribution of preperiodic points in one-parameter families* (p. 80)
17:00 - 17:30	Sourabhashis Das (University of Waterloo), *On the number of irreducible factors with a given multiplicity in function fields* (p. 78)
17:30 - 18:00	Liam Orovec (University of Waterloo), *Small Univoque Bases* (p. 81)

Monday June 5 — lundi 5 juin

8:00 - 8:30	William Verreault (Université Laval), *Sums of arithmetic functions running on factorials* (p. 82)
8:30 - 9:00	Yash Totani (University of Waterloo), *On the problem of representing integers by quadratic forms* (p. 81)
9:00 - 9:30	Daniel Johnstone (University of Toronto), *A construction of some Stable Transfer Operators* (p. 80)
9:30 - 10:00	Marti Roset Julia (McGill University), *The Gross–Kohnen–Zagier theorem via p-adic uniformization* (p. 80)
10:00 - 10:30	Nic Fellini (Queen's University), *Variations of a conjecture of Ankeny-Artin-Chowla* (p. 79)
15:00 - 15:30	Mihir Deo (University of Ottawa), *Factorization of unbounded p-adic L-functions* (p. 78)
15:30 - 16:00	Malors Espinosa Lara (University of Toronto), *A Symbol from Beyond Endoscopy* (p. 80)

Abstracts/Résumés

JÉRÉMY CHAMPAGNE, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 257]
Diophantine approximation by linear forms with angular restrictions

Diophantine approximation by linear forms can be understood as follows: Given real numbers $\alpha_1, ..., \alpha_n$, one seeks integers $q_1, ..., q_n, p$ such that the value of the linear form $q_1\alpha_1 + \cdots + q_n\alpha_n - p$ is *small* in comparison to the size of $q_1, ..., q_n$ (consider the uncanny smallness of $2\pi + e - 9$, for example).

In this talk, we consider the case where the point $\mathbf{x} = (q_1, ..., q_n, p)$ is required to make a bounded angle with a prescribed subspace of $\mathbb{R}^{n+1}$. We give an optimal lower bound for the exponent of approximation in this context, which surprisingly only depends on the dimension of the prescribed subspace.

This is joint work with Damien Roy.

SOURABHASHIS DAS, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 17:00 – LMX 257]
On the number of irreducible factors with a given multiplicity in function fields

Let $k \geq 1$ be a natural number and $f \in \mathbb{F}_q[t]$ be a monic polynomial. Let $\omega_k(f)$ denote the number of distinct monic irreducible factors of f with multiplicity k. In this talk, we show that the function $\omega_1(f)$ has a normal order $\log(\deg(f))$ and also satisfies the Erdös-Kac Theorem. We also show that the functions $\omega_k(f)$ with $k \geq 2$ do not have normal order. Such results are obtained by studying the first and the second moments of $\omega_k(f)$ which we explain in brief. This is joint work with Ertan Elma, Wentang Kuo, and Yu-Ru Liu.

MIHIR DEO, University of Ottawa
[Monday June 5 / lundi 5 juin, 15:00 – LMX 257]
Factorization of unbounded p-adic L-functions

Let F_α, F_β be two power series over a finite extension of the field of p-adic numbers $\mathbb{Q}_p$ satisfying certain interpolation formulae. Suppose further that the coefficients of the power series have unbounded denominators satisfying certain growth condition. In this talk, we will discuss the decomposition of F_α and F_β into linear combinations of two power series with integral coefficients. We use p-adic Hodge theory, in particular the theory of Wach modules and Perrin-Riou's p-adic regulator to construct a logarithmic matrix (in the spirit of Sprung and Lei-Loeffler-Zerbes) which is used in the factorization. This is an extension of a result of Büyükboduk-Lei and is a part of my ongoing project which deals with the factorization of two variable p-adic L-function attached to a small slope Bianchi modular form constructed by Williams.

JASON FANG AND ANTON MOSUNOV, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 257]
A Lower Bound for the Area of the Fundamental Region of a Binary Form

Let

$$F(x, y) = \prod_{k=1}^{n} (\delta_k x - \gamma_k y)$$

be a binary form of degree $n \geq 1$, with complex coefficients, written as a product of n linear forms in $\mathbb{C}[x, y]$. Let

$$h_F = \prod_{k=1}^{n} \sqrt{|\gamma_k|^2 + |\delta_k|^2}$$

denote the height of F and let A_F denote the area of the fundamental region $\mathcal{D}_F$ of F:

$$\mathcal{D}_F = \left\{(x, y) \in \mathbb{R}^2 \colon |F(x, y)| \leq 1\right\}.$$

We prove that $h_F^{2/n} A_F \geq \left(2^{1+(r/n)}\right)\pi$, where r is the number of roots of F on the real projective line $\mathbb{RP}^1$, counting multiplicity.

NIC FELLINI, Queen's University
[Monday June 5 / lundi 5 juin, 10:00 – LMX 257]
Variations of a conjecture of Ankeny-Artin-Chowla

A famous conjecture of Ankeny, Artin and Chowla relates the class number of a real quadratic field $\mathbb{Q}(\sqrt{p})$ with p a prime congruent to $1 \bmod 4$ with its fundamental unit $\varepsilon = (t + u\sqrt{p})/2$ via a congruence $\bmod p$. In particular, the Ankeny-Artin-Chowla (AAC) conjecture states that u is not divisible by p. The significance of their conjecture lies in the fact that it provides an arithmetic way of computing the class number of $\mathbb{Q}(\sqrt{p})$ for p a prime congruent to $1 \bmod 4$. We will discuss the history and techniques of their work as well as show that there are further connections with Fermat quotients and Wieferich style congruences. This is joint work with M. Ram Murty.

SAMPRIT GHOSH, University of Toronto
[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 257]
Higher Euler-Kronecker coefficients

The coefficients that appear in the Laurent series of Dedekind zeta functions and their logarithmic derivatives, about $s = 1$, are mysterious and seem to contain a lot of arithmetic information. Although the residue and the constant term have been widely studied, not much is known about the higher coefficients. In this talk, we present some results about these coefficients $\gamma_{K,n}$ that appear in the Laurent series expansion of $\frac{\zeta_K'(s)}{\zeta_K(s)}$ about $s = 1$, where K is a global field. For example, when K is a number field, we prove, under GRH, (if d_K is the absolute discriminant of K)

$$\gamma_{K,n} \ll (\log(\log(|d_K|))^{n+1}$$

TONY HADDAD, Université de Montréal
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 257]
A coupling for the prime factors of a random integer

The sizes of large prime factors for a random integer N sampled uniformly in $[1, x]$ are known to converge in distribution to a Poisson-Dirichlet process $\mathbf{V} = (V_1, V_2, \ldots)$ as $x \to \infty$. In 2002, Arratia constructed a coupling of N and $\mathbf{V}$ satisfying $\mathbb{E}\sum_i |\log P_i - (\log x)V_i| = O(\log\log x)$ where $P_1 P_2 \cdots$ is the unique factorization of N with $P_1 \geqslant P_2 \geqslant \cdots$ being all primes or ones. He conjectured that there exists a coupling for which this expectation is $O(1)$.

I will present a modification of his coupling which proves his conjecture, and show that $O(1)$ is optimal. As a corollary, I will provide a simpler proof of the arcsine law in the average distribution of divisors proved by Deshouillers, Dress and Tenenbaum in 1979. This is joint work with Dimitris Koukoulopoulos.

TING HAN HUANG, Concordia University
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 257]
Special values of triple product p-adic L-functions and p-adic Abel-Jacobi maps

In 2013, H. Darmon and V. Rotger proved the so-called p-adic Gross-Zagier formula, which relates the value of the triple product p-adic L-function for Hida families at a certain balanced classical weight, to an image of the p-adic Abel-Jacobi map of the generalized diagonal cycle.

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.

DANIEL JOHNSTONE, University of Toronto
[Monday June 5 / lundi 5 juin, 9:00 – LMX 257]
A construction of some Stable Transfer Operators

In this talk I will discuss some recent progress on the construction of Stable Transfer Operators $\mathfrak{S}^{\phi}$ associated to an L-embedding $\phi : {}^{L}\mathrm{GL}_n \to {}^{L}G$. While many such explicit constructions remain out of reach, I will discuss a manner in which this general case can be largely reduced to an understanding of the case of an embedding $\phi : {}^{L}S \to {}^{L}G$ for a maximal torus S of GL_n. This method relies on building sections for the transfer maps associated to the embeddings ${}^{L}S \to {}^{L}\mathrm{GL}_n$ for each maximal torus S of GL_n, in addition to a related family of related maps. As a guiding example, I will give a construction of the transfer associated to the diagonal embedding ${}^{L}\mathrm{GL}_n \to {}^{L}\mathrm{GL}_n \times \mathrm{GL}_n$ which ought to be considered as a type of non-abelian convolution on the space of orbital integrals on the Steinberg-Hitchin base of GL_n.

MARTI ROSET JULIA, McGill University
[Monday June 5 / lundi 5 juin, 9:30 – LMX 257]
The Gross–Kohnen–Zagier theorem via p-adic uniformization

Let S be a set of rational primes 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. This is joint work in progress with Lea Beneish, Henri Darmon and Lennart Gehrmann.

VALERIYA KOVALEVA, CRM/Universite de Montreal
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 257]
Correlations of the Riemann Zeta on the critical line

In this talk we will discuss the behaviour of the Riemann zeta on the critical line, and in particular, its correlations in various ranges. We will prove a new result for correlations of squares, where shifts may be up to size $T^{6/5-\varepsilon}$. We will also explain how this result relates to Motohashi's formula for the fourth moment, as well as the moments of moments of the Riemann Zeta and its maximum in short intervals.

MALORS ESPINOSA LARA, University of Toronto
[Monday June 5 / lundi 5 juin, 15:30 – LMX 257]
A Symbol from Beyond Endoscopy

To carry out the process of Beyond Endoscopy, as proposed by Langlands around 2000, for Gl(2) for general number fields it is necessary to be able to write the Hecke Sign Character in a very explicit form. For the rational numbers this is achieved via the Kronecker Symbol, but for other number fields it is not so straightforward how to do it in the way needed for Beyond Endoscopy.

In a joint work with Melissa Emory, Debanjana Kundu and Tian An Wong, we developed a way to do this by modifying in a precise way several local Hilbert Symbols and thus recovering the sign character in the explicit way we require. In this talk I will talk about this construction, some examples of it and why it was needed as well as some questions we are not yet able to settle related to it.

Early Career Research in Number Theory
Recherche en début de carrière en théorie des nombres

MATT OLECHNOWICZ, University of Toronto
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 257]
Distribution of preperiodic points in one-parameter families

Let f_t be a one-parameter family of rational maps (of degree at least 2) defined over a number field K. We show that for all t outside of a set of natural density zero, every K-rational preperiodic point of f_t is the specialization of some $K(T)$-rational preperiodic point of f. Assuming a weak form of the Uniform Boundedness Conjecture, we also find the average number of K-rational preperiodic points of any family, and give some examples where this holds unconditionally. This talk will not assume any prior knowledge of arithmetic dynamics.

LIAM OROVEC, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 17:30 – LMX 257]
Small Univoque Bases

For a positive number q, we say (ε_i) is a q-expansion for x provided, $x = \sum_{i=1}^{\infty} \frac{\varepsilon_i}{q^i}$. Working over the alphabet $\mathcal{A} = \{0, 1, \ldots, M\}$ we look at finding, given a fixed positive real number x, the smallest base $q_s(x)$ for which x has a unique $q_s(x)$-expansion.

We will first establish the result for $x = 1$. Then using relations between the representation of 1 under base $q_s(x)$ and the possible unique representation of real numbers we determine whether $q_s(x) \leq q_s(1)$ which will aid us in calculating the desired value.

This is a generalization of the work of D. Kong who established the results for $M = 1$. The study of such bases is important as most x have an infinite number of representations under an arbitrary base q.

SHUYANG SHEN, University of Toronto
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 257]
On Irreducible Trinomials

Consider the family of monic trinomials $f(x) = x^n + lx^m + a$ in $\mathbb{Z}[x]$. We present a classification of reducible polynomials in this family, and discuss the Galois groups of irreducible trinomials. This is joint work with Kumar Murty.

MATTHEW SUNOHARA, University of Toronto
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 257]
On stable transfer operators and functorial transfer kernels

Langlands introduced stable transfer operators as a fundamental part of his proposal of Beyond Endoscopy. They are intended to be used in comparisons of his proposed refinements of stable trace formulas, in an analogous role to that of endoscopic transfer operators in the theory of Endoscopy. The existence of stable transfer operators for real groups is readily established, but there remains the problem of obtaining explicit formulas for their distributional kernels, the so-called stable transfer factors or functorial transfer kernels. We will discuss stable transfer between tori, complex groups, and work in progress on stable transfer from real groups to tori, which would include a generalisation of the Gelfand-Graev formula for stable discrete series characters of SL(2).

Early Career Research in Number Theory
Recherche en début de carrière en théorie des nombres

YASH TOTANI, University of Waterloo
[Monday June 5 / lundi 5 juin, 8:30 – LMX 257]
On the problem of representing integers by quadratic forms

Historically, one of the most extensively studied problem in the theory of quadratic forms is finding the number of representations of an integer by a quadratic form. A well known result in this area is Jacobi's four square theorem which gives explicit formulas for the number of representations of an integer n as a sum of four squares. Another interesting insight was given by Fred van der Blij in a 1952 paper, where he gives exact formulas for the number of representations for all three equivalence classes of quadratic forms Q of discriminant -23. In this talk, we look at a generalization of the above result for other values of the discriminant $D < 0$, such that $\mathbb{Q}(\sqrt{D})$ has class number three, using the theory of modular forms.

WILLIAM VERREAULT, Université Laval
[Monday June 5 / lundi 5 juin, 8:00 – LMX 257]
Sums of arithmetic functions running on factorials

We examine the behavior of common arithmetic functions at factorial arguments. For various arithmetic functions f, the asymptotic behavior of $f(n!)$, $\sum_{n\leq N} f(n!)$, and $f(n!)/f((n-1)!)$ is obtained. An analogue of Chowla's conjecture for factorial arguments is also investigated.

This is joint work with Jean-Marie De Koninck.

Equivariant Schubert calculus and beyond
Calcul de Schubert équivariant et plus encore

Org: Edward Richmond (Oklahoma State) and/et **Kirill Zainoulline** (University of Ottawa)

Research in Schubert calculus involves a rich variety of techniques coming from representation theory and combinatorics. The interactions between these techniques yield interesting connections between objects such as symmetric functions, partitions, root systems and Coxeter groups. This session will focus on new results and developments in cohomology theories of flag varieties and modern equivariant Schubert calculus ; junior researchers are encouraged to apply.

La recherche sur le calcul de Schubert fait appel à une grande variété de techniques issues de la théorie des représentations et de la combinatoire. Les interactions entre ces techniques produisent des connexions intéressantes entre des objets tels que les fonctions symétriques, les partitions, les systèmes de racines et les groupes de Coxeter. Cette session se concentrera sur les nouveaux résultats et développements des théories de cohomologie des variétés drapeaux et du calcul de Schubert équivariant moderne ; les jeunes chercheurs et chercheuses sont encouragés à candidater.

Schedule/Horaire **Room/Salle: STEM 464**

Monday June 5 **lundi 5 juin**

8:30 - 9:00	Dennin Hugh (Ohio State), *Bijective proofs of derivative formulas for Schubert polynomials* (p. 83)
9:00 - 9:30	George Seelinger (University of Michigan), *K-theoretic Catalan functions* (p. 84)
9:30 - 10:00	Weihong Xu (Virginia Tech), *A presentation for the quantum K ring of partial flag manifolds* (p. 85)
10:00 - 10:30	Rui Xiong (University of Ottawa), *Automorphisms of the Quantum Cohomology of the Springer Resolution and Applications* (p. 84)
15:00 - 15:30	Reuven Hodges (University of California San Diego), *Levi-spherical Schubert varieties* (p. 83)
15:30 - 16:00	Mihail Tarigradschi (Rutgers), *Classifying cominuscule Schubert varieties up to isomorphism* (p. 84)
16:00 - 16:30	Minyoung Jeon (University of Georgia), *Mather classes of Schubert varieties via small resolutions* (p. 83)
16:30 - 17:00	Nathan Lesnevich (Washington University in St. Louis), *Splines on Cayley Graphs of the Symmetric Group* (p. 84)

Abstracts/Résumés

REUVEN HODGES, UC San Diego
[Monday June 5 / lundi 5 juin, 15:00 – STEM 464]
Levi-spherical Schubert varieties

I will present a root-system uniform, combinatorial classification of Levi-spherical Schubert varieties for any generalized flag variety G/B of finite Lie type. This will be applied to the study of multiplicity-free decompositions of a Demazure module into irreducible representations of a Levi subgroup.

DENNIN HUGH, The Ohio State University
[Monday June 5 / lundi 5 juin, 8:30 – STEM 464]
Bijective proofs of derivative formulas for Schubert polynomials

Recently, Gaetz and Gao extended a lowering operator ∇ on weak order, first introduced by Stanley, to an $\mathfrak{sl}_2$ poset representation, thus proving the strong Sperner property of weak order. Hamaker, Pechenik, Speyer, and Weigandt later showed that ∇ can be realized as a certain differential operator on Schubert polynomials which, in particular, gives a short proof of the Macdonald reduced word identity. In this talk, we give bijective proofs of this and related derivative identities for Schubert polynomials and β-Grothendieck polynomials using the combinatorics of pipe dreams.

Equivariant Schubert calculus and beyond
Calcul de Schubert équivariant et plus encore

MINYOUNG JEON, University of Georgia
[Monday June 5 / lundi 5 juin, 16:00 – STEM 464]
Mather classes of Schubert varieties via small resolutions

The Chern-Mather class is a characteristic class, generalizing the Chern classes of tangent bundles of nonsingular varieties to singular varieties. It uses the Nash-blowup for singular varieties instead of the tangent bundles. In this talk, we consider Schubert varieties, known as singular varieties in most cases, in the even orthogonal Grassmannians and discuss the work computing the Chern-Mather classes of the Schubert varieties by the use of the small resolutions of Sankaran and Vanchinathan with Jones' technique. We also describe the Kazhdan-Lusztig class of Schubert varieties in Lagrangian Grassmannians, as analogous results if time permitted.

NATHAN LESNEVICH, Washington University in St Louis
[Monday June 5 / lundi 5 juin, 16:30 – STEM 464]
Splines on Cayley Graphs of the Symmetric Group

A spline is an assignment of polynomials to the vertices of a polynomial-edge-labeled graph, where the difference of two vertex polynomials along an edge must be divisible by the edge label. The ring of splines is a combinatorial generalization of the GKM construction for equivariant cohomoloy rings of flag, Schubert, Hessenberg, and permutohedral varieties. We consider spline rings where the underlying graph is the Cayley graph of a symmetric group generated by an arbitrary collection of transpositions. In this talk, we will give an example of when this ring is not a free module over the polynomial ring, and give a connectivity condition that precisely describes when particular graded pieces are generated by equivariant Schubert classes.

GEORGE SEELINGER, University of Michigan
[Monday June 5 / lundi 5 juin, 9:00 – STEM 464]
K-theoretic Catalan functions

In 2008, Thomas Lam identified a family of symmetric functions known as k-Schur functions with the Schubert classes in the homology of the affine Grassmannian, in analogy with Schur functions serving as representatives for the (co)homology of the usual Grassmannian. Of additional interest, under an isomorphism between the quantum cohomology of the flag variety and the homology of the affine Grassmannian, known as the Peterson isomorphism, the quantum Schubert polynomials are sent to the k-Schur functions, up to suitable localization. Subsequently, much work had been done to carry out an analogous program in the K-theoretic generalization, but significant parts of the combinatorics of the symmetric function Schubert representatives remained elusive. In this talk, I will present how some new insights in the (co)homological setting enabled a K-theoretic refinement to give a direct understanding of some of the missing combinatorics surrounding the K-homology of the affine Grassmannian and the K-theoretic Peterson isomorphism.

MIHAIL TARIGRADSCHI, Rutgers University
[Monday June 5 / lundi 5 juin, 15:30 – STEM 464]
Classifying cominuscule Schubert varieties up to isomorphism

Cominuscule flag varieties generalize Grassmannians to other Lie types. Schubert varieties in cominuscule flag varieties are then indexed by posets of roots labeled long/short. These labeled posets generalize the Young diagrams that index Schubert varieties in Grassmannians. We discuss the question of how these posets determine the isomorphism class of a Schubert variety.

RUI XIONG, University of Ottawa
[Monday June 5 / lundi 5 juin, 10:00 – STEM 464]
Automorphisms of the Quantum Cohomology of the Springer Resolution and Applications

Equivariant Schubert calculus and beyond
Calcul de Schubert équivariant et plus encore

In this talk, we introduce quantum Demazure-Lusztig operators acting on the equivariant quantum cohomology of the Springer resolution. Our main result is a presentation of the torus-equivariant quantum cohomology in terms of generators and relations. We also provide explicit descriptions for the classical types and recover earlier results for complete flag varieties.

WEIHONG XU, VirginiaTech

[Monday June 5 / lundi 5 juin, 9:30 – STEM 464]

A presentation for the quantum K ring of partial flag manifolds

We give a conjectured generalization of the Whitney presentation for the (equivariant) quantum K ring of Grassmannians by Gu, Mihalcea, Sharpe, and Zou to all partial flag manifolds, and prove it for Fl(1, n-1, n). The presentation arises from realizations of partial flag manifolds as Gauged Linear Sigma Models and highlights the structure of these manifolds as towers of Grassmann bundles. We also verify the specialization of this conjecture in quantum cohomology by comparing it with a presentation given by Gu and Kalashnikov using the abelian/non-abelian correspondence in mathematics. This is joint work with Gu, Mihalcea, Sharpe, Zhang, and Zou.

Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics
Topologie géométrique, applications pseudo-Anosov et dynamique complexe

Org: Mariam Alhawaj, **Giulio Tiozzo** and/et **Abdul Zalloum** (University of Toronto)

The interplay of geometric topology and complex dynamics have proved to be fruitful. Since the work of Thurston and his introduction of pseudo-Anosov homeomorphisms there have been many recent new developments, including the construction of generalized pseudo-Anosov from Hubbard trees and the new progress in the twisted rabbit problem using combinatorial methods. The goal of this session is to bring experts of both fields in order to develop new connections between the two areas.

L'interaction entre la topologie géométrique et la dynamique complexe s'est avérée fructueuse. Depuis le travail de Thurston et son introduction des homéomorphismes de pseudo-Anosov, il y a eu de nombreux développements récents, y compris la construction de pseudo-Anosov généralisés à partir d'arbres de Hubbard et les nouveaux progrès dans le problème du lapin tordu en utilisant des méthodes combinatoires. L'objectif de cette session est de réunir des experts des deux domaines afin de développer de nouvelles connexions entre les deux domaines.

Schedule/Horaire **Room/Salle: STEM 201**

Saturday June 3 **samedi 3 juin**

8:30 - 9:10	George Domat (Fields), *Coarse Geometry of Big Mapping Class Groups of Graphs* (p. 87)
9:10 - 9:50	Mariam Al-Hawaj (University of Toronto), *Generalized pseudo-Anosov Maps and Hubbard Trees* (p. 86)
9:50 - 10:30	Mireille Soergel (ETH), *An introdution to Dyer groups* (p. 89)
15:00 - 15:40	Chenxi Wu (University of Wisconsin), *Sub shift of finite types induced by linear order* (p. 89)
15:40 - 16:20	Malavika Mukundan (University of Michigan), *Twisting problems in complex dynamics* (p. 88)
16:20 - 17:00	Sami Douba (Institut des Hautes Études Scientifiques), *On regular subgroups of* $\mathrm{SL}_3(\mathbb{R})$ (p. 87)
17:00 - 17:40	Rylee Lyman (Rutgers University), *CTs for Free Products* (p. 88)

Sunday June 4 **dimanche 4 juin**

8:30 - 9:10	Reila Zheng (University of Toronto), *Sharkovsky's Ordering on the Mandelbrot Set* (p. 89)
9:10 - 9:50	Karl Winsor (Fields Institute), *Pseudo-Anosov homeomorphisms and interval maps* (p. 89)
9:50 - 10:30	Annette Karrer (McGill), *From Stallings' Theorem to connected components of Morse boundaries of graph of groups* (p. 87)
15:00 - 15:40	Ilya Kazachkov (Fields institute), *Real Cubings* (p. 87)
15:40 - 16:20	Harry Petyt (Oxford), ℓ^p *nonpositive curvature* (p. 88)
16:20 - 17:00	Alice Kerr (Bristol), *Loxodromic elements in right-angled Artin groups* (p. 88)
17:00 - 17:40	Thomas Haettel (CRM Montréal), *Garside groups and nonpositive curvature* (p. 87)

Abstracts/Résumés

MARIAM AL-HAWAJ, University of Toronto
[Saturday June 3 / samedi 3 juin, 9:10 – STEM 201]
Generalized pseudo-Anosov Maps and Hubbard Trees

The Nielsen-Thurston classification of the mapping classes proved that every orientation preserving homeomorphism of a closed surface, up to isotopy is either periodic, reducible, or pseudo-Anosov. Pseudo-Anosov maps have particularly nice structure because they expand along one foliation by a factor of $\lambda > 1$ and contract along a transversal foliation by a factor of $\frac{1}{\lambda}$. The number λ is called the dilatation of the pseudo-Anosov. Thurston showed that every dilatation λ of a pseudo-Anosov map is an algebraic unit, and conjectured that every algebraic unit λ whose Galois conjugates lie in the annulus $A_\lambda = \{z : \frac{1}{\lambda} < |z| < \lambda\}$ is a dilatation of some pseudo-Anosov on some surface S.

Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics
Topologie géométrique, applications pseudo-Anosov et dynamique complexe

Pseudo-Anosovs have a huge role in Teichmuller theory and geometric topology. The relation between these and complex dynamics has been well studied inspired by Thurston.

In this project, I develop a new connection between the dynamics of quadratic polynomials on the complex plane and the dynamics of homeomorphisms of surfaces. In particular, given a quadratic polynomial, we show that one can construct an extension of it which is generalized pseudo-Anosov homeomorphism. Generalized pseudo-Anosov means the foliations have infinite singularities that accumulate on finitely many points. We determine for which quadratic polynomials such an extension exists. My construction is related to the dynamics on the Hubbard tree which is a forward invariant subset of the filled Julia set that contains the critical orbit.

GEORGE DOMAT, Rice University/Fields Institute
[Saturday June 3 / samedi 3 juin, 8:30 – STEM 201]
Coarse Geometry of Big Mapping Class Groups of Graphs

We will introduce an analogue of big mapping class groups as defined by Algom-Kfir and Bestvina that hopes to answer the question: What is "Big Out(F_n)" ? This group will consist of proper homotopy classes of proper homotopy equivalences of locally finite, infinite graphs. We will then discuss some classification theorems related to the coarse geometry of these groups. This is joint work with Hannah Hoganson and Sanghoon Kwak.

SAMI DOUBA, Institut des Hautes Études Scientifiques
[Saturday June 3 / samedi 3 juin, 16:20 – STEM 201]
On regular subgroups of $\mathrm{SL}_3(\mathbb{R})$

Motivated by a question of M. Kapovich, we show that the $\mathbb{Z}^2$ subgroups of $\mathrm{SL}_3(\mathbb{R})$ that are *regular* in the sense of Kapovich–Leeb–Porti are precisely the lattices in minimal horospherical subgroups. By work of Oh, it then follows that a Zariski-dense discrete subgroup Γ of $\mathrm{SL}_3(\mathbb{R})$ contains a regular $\mathbb{Z}^2$ if and only if Γ is commensurable to a conjugate of $\mathrm{SL}_3(\mathbb{Z})$. In particular, a Zariski-dense regular subgroup of $\mathrm{SL}_3(\mathbb{R})$ contains no $\mathbb{Z}^2$ subgroups. This is joint work with Konstantinos Tsouvalas.

THOMAS HAETTEL, IRL CRM Montréal
[Sunday June 4 / dimanche 4 juin, 17:00 – STEM 201]
Garside groups and nonpositive curvature

I will present Garside groups, with basic examples coming from braid groups. I will discuss nonpositive curvature properties of Garside groups, and I will mention recent results concerning Garside structures for some Artin groups, in joint work with Jingyin Huang.

ANNETTE KARRER, McGill University
[Sunday June 4 / dimanche 4 juin, 9:50 – STEM 201]
From Stallings' Theorem to connected components of Morse boundaries of graph of groups

Every finitely generated group G has an associated topological space, called a Morse boundary. It was introduced by a combination of Cordes and Charney–Sultan and captures the hyperbolic-like behavior of G at infinity.

At the beginning of the talk, I will recap Stallings' theorem and an analogous statement for Gromov boundaries of Gromov-hyperbolic groups. As Morse boundaries generalize Gromov boundaries, it raises the question whether it is possible to formulate an analog for Morse boundaries. Motivated by this question, we will study connected components of Morse boundaries of graph of groups. We will focus on the case where the edge groups are undistorted and do not contribute to the Morse boundary of the ambient group. Results presented are joint with Elia Fioravanti.

Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics
Topologie géométrique, applications pseudo-Anosov et dynamique complexe

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ILYA KAZACHKOV, Ikerbasque - Basque Foundation for Science
[Sunday June 4 / dimanche 4 juin, 15:00 – STEM 201]
Real Cubings

The theory of real trees and groups acting on them has had a deep impact on Group Theory by providing tools to attack new problems, by simplifying proofs of classical results, and by establishing new connections between group theory and geometry, topology, dynamical systems and model theory.

In this talk, we will introduce a new class of metric spaces, called real cubings, which we view as higher-dimensional real trees. We will describe their structure and characterise them from different viewpoints.

As hyperbolic groups are linked to real trees via their asymptotic cone, we will show that real cubings are connected to hierarchically hyperbolic groups, a class of groups that contains right-angled Artin groups and the mapping class groups of closed surfaces.

We will then speculate why we believe that a good theory of groups acting on real cubings is possible. The talk is based on joint work with Montserrat Casals-Ruiz and Mark Hagen.

ALICE KERR, University of Bristol
[Sunday June 4 / dimanche 4 juin, 16:20 – STEM 201]
Loxodromic elements in right-angled Artin groups

The ability to quickly generate loxodromic elements in an action on a hyperbolic space is key to many statements about exponential type growth. In mapping class groups these elements are the pseudo-Anosovs acting on the associated curve graph, and here results of this type are already known. We will discuss how we can acheive similar results for the action of right-angled Artin groups on their associated extension graph, by using an embedding of these groups into mapping class groups.

RYLEE LYMAN, Rutgers University–Newark
[Saturday June 3 / samedi 3 juin, 17:00 – STEM 201]
CTs for Free Products

Parallel to the theory of pseudo-Anosov homeomorphisms is the theory of train track maps for free group automorphisms. Since free group automorphisms may admit more complicated behavior than surface mapping classes, more generally one considers relative versions of train track maps. These come in many flavors, the strongest of which are CTs. I will give the idea of a CT and discuss a generalization to free products.

MALAVIKA MUKUNDAN, University of Michigan
[Saturday June 3 / samedi 3 juin, 15:40 – STEM 201]
Twisting problems in complex dynamics

The problem of "twisting" in complex dynamics concerns the post-composition of a postcritically finite polynomial with an orientation-preserving homeomorphism that fixes the postcritical set pointwise. We give an introduction to twisting via the original "twisted rabbit problem" and explore its connections to Teichmüller theory and geometric groups as we walk through a survey of solutions, generalizations and questions for the future.

HARRY PETYT, University of Oxford
[Sunday June 4 / dimanche 4 juin, 15:40 – STEM 201]
ℓ^p nonpositive curvature

Geometric Topology, pseudo-Anosov Maps, and Complex Dynamics
Topologie géométrique, applications pseudo-Anosov et dynamique complexe

Many groups can be effectively studied using metric spaces modelled on ℓ^1, ℓ^2, or ℓ^∞ geometry. Motivated by this observation, in this talk we consider cell complexes equipped with an ℓ^p metric for arbitrary p. Based on joint work with Thomas Haettel and Nima Hoda.

MIREILLE SOERGEL, ETH Zürich
[Saturday June 3 / samedi 3 juin, 9:50 – STEM 201]
An introdution to Dyer groups

In this talk, we will introduce Dyer groups, a family of groups, which contains both, Coxeter groups and right-angled Artin groups. We will discuss some geometric and algebraic properties of Dyer groups.

KARL WINSOR, Fields Institute
[Sunday June 4 / dimanche 4 juin, 9:10 – STEM 201]
Pseudo-Anosov homeomorphisms and interval maps

Thurston classified the topological entropies of post-critically finite self-maps of the unit interval, solving a 1-dimensional analogue of the problem of classifying stretch factors of pseudo-Anosov surface homeomorphisms. Motivated by this work, we will describe a natural class of pseudo-Anosov homeomorphisms whose dynamics are closely related to the dynamics of interval maps. Specifically, we will show that pseudo-Anosov homeomorphisms of a punctured sphere whose quadratic differential has a single zero induce interval maps via their action on certain train tracks. One application of this result is a uniform lower bound of $\sqrt{2}$ for the associated stretch factors, recovering a result of Boissy-Lanneau. This is joint work with Ethan Farber.

CHENXI WU, UW Madison
[Saturday June 3 / samedi 3 juin, 15:00 – STEM 201]
Sub shift of finite types induced by linear order

I will discuss some monotonicity results of the poles of Artin Mazur zeta functions for certain families of sub shifts of finite types, generalizing previous results I had with Kathryn Lindsey, Harrison Bray, Diana Davis and Giulio Tiozzo on the Galois conjugates of conjugates of polynomial core entropies. I will also discuss ongoing work that looks at possible applications to p-adic dynamics.

REILA ZHENG, University of Toronto
[Sunday June 4 / dimanche 4 juin, 8:30 – STEM 201]
Sharkovsky's Ordering on the Mandelbrot Set

Sharkovsky's Theorem is the classical result on the forcing and existence of periodic orbits of a continuous interval map. In my talk I will describe the generalized Sharkovsky's ordering on the Mandelbrot set.

Geometry for Partial Differential Equations
Géométrie pour les équations différentielles partielles

Org: Goong Chen (Texas A&M University), **Jie Xiao** (Memorial University) and/et **Ning Zhang** (Central China University of Science and Technology)

This scientific session will bring together researchers who work in partial differential equations (PDEs) with applications to computer science and mathematical physics. Topics will include efficient techniques of computational-convex-differential geometry and harmonic-numerical-potential analysis, and applications.

Cette session scientifique réunira des chercheurs qui travaillent sur les équations aux dérivées partielles (EDP) avec des applications en informatique et en physique mathématique. Les sujets abordés comprendront des techniques efficaces de géométrie différentielle convexe computationnelle et d'analyse potentielle numérique harmonique, ainsi que des applications.

Schedule/Horaire **Room/Salle: LMX 241**

Saturday June 3 **samedi 3 juin**

8:00 - 9:00	Goong Chen (Texas A&M University), *Animal Motions and Their Fourier Decomposition* (p. 91)
9:00 - 9:30	Daniel Spector (Taiwan Normal University) (p. 92)
9:30 - 10:00	Deping Ye (Memorial University), *Mou He Fang Gai: A legend over thousands years* (p. 93)
10:00 - 10:40	Parisa Fatheddin (Ohio State University), *Asymptotic Behavior of Stochastic Navier-Stokes and Schrodinger Equations* (p. 91)
15:00 - 15:40	Chong Wang (Washington and Lee University), *Periodic Minimizers of A Ternary Nonlocal Isoperimetric Problem* (p. 92)
15:40 - 16:20	Jerome Quintin (University of Waterloo), *Toward a non-perturbative understanding of a non-singular universe* (p. 92)
16:20 - 17:00	Qi S. Zhang (University of California Riverside), *Log gradient estimates of the heat equation on manifolds.* (p. 93)

Sunday June 4 **dimanche 4 juin**

8:30 - 9:00	Eric Woolgar (University of Alberta), *Uniqueness problems for quasi-Einstein equations* (p. 93)
9:00 - 9:30	Tuoxin Li (University of British Columbia), *Beckner's inequality for axially symmetric functions on $\mathbb{S}^4$ and $\mathbb{S}^6$* (p. 91)
9:30 - 10:00	Haifeng Hu (McGill University), *Structural Stability for 1D Semiconductor Hydrodynamic Model with Sonic Boundary* (p. 91)
10:00 - 10:30	Kazuo Yamazaki (Texas Tech University), *Recent developments for convex integration on fluid PDEs* (p. 93)
15:00 - 15:40	Xinyang Lu (Lakehead University), *Regularity of equations from epitaxial growth* (p. 92)
15:40 - 16:20	Shaohua Chen (Cape Breton University), *Global solutions for the 1-D compressible Euler equations with time-dependent damping* (p. 91)
16:20 - 17:00	Paula Burkhardt-Guim (New York University), *ADM mass for C^0 metrics and distortion under Ricci-DeTurck flow* (p. 90)

Abstracts/Résumés

PAULA BURKHARDT-GUIM, NYU Courant
[Sunday June 4 / dimanche 4 juin, 16:20 – LMX 241]
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.

GOONG CHEN, Mathematics Department, Texas A&M University
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 241]
Animal Motions and Their Fourier Decomposition

in this talk, we first compute the fundamental modes of motion of certain animals. We then computationally analyze their motion by performing Fourier transforms on their trajectory. Their frequencies show strong consistency with the computed frequencies of the fundamental modes of motion. Concrete examples will be illustrated.

SHAOHUA CHEN, Cape Breton University
[Sunday June 4 / dimanche 4 juin, 15:40 – LMX 241]
Global solutions for the 1-D compressible Euler equations with time-dependent damping

In this talk we discuss the Cauchy problem for the 1-D compressible Euler equations with time-dependent damping. We prove the existence of global solutions under the assumptions that the derivatives of initial data are suitable small and the initial volume is large without the condition of small perturbations to the constant initial data. Our approach is based on estimates of the derivatives of Riemann invariants along two characteristic curves.

PARISA FATHEDDIN, Ohio State University, Marion
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 241]
Asymptotic Behavior of Stochastic Navier-Stokes and Schrodinger Equations

We will consider the stochastic Navier-Stokes and stochastic Schrodinger equations and discuss their asymptotic limits such as large and moderate deviations, central limit theorem and the law of the iterated logarithm. To achieve the large deviation principle, we apply both techniques available in the literature: Azencott method and the weak convergence approach and compare the two methods. The Azencott method is then used to derive the law of the iterated logarithm. Also I will discuss my recently published book for graduate students: "Teaching and Research in Mathematics: A Guide with applications to Industry".

HAIFENG HU, McGill University
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 241]
Structural Stability for 1D Semiconductor Hydrodynamic Model with Sonic Boundary

In this talk, I will present our recent research on the structural stability of interior subsonic steady states to the hydrodynamic model for semiconductors with sonic boundary. More precisely, we show that the small perturbation in the subsonic doping profiles leads to the small difference between the corresponding interior subsonic solutions. While it has been proved that this model possesses various physical steady states such as the interior subsonic, interior supersonic, shock transonic and smooth transonic solutions, the singularities at the sonic boundary make it difficult to investigate the structural stability of these solutions. To address this issue, we propose a novel approach, which combines the weighted multiplier technique, local singularity analysis, monotonicity argument and squeezing skill. Our work indicates that the interior subsonic solutions are at least amenable to this approach. Numerical approximations further confirm our theoretical results. These results to some extent provide insights into the structural stability of other types of solutions. This is the joint work with Yuehong Feng and Ming Mei.

Geometry for Partial Differential Equations
Géométrie pour les équations différentielles partielles

TUOXIN LI, University of British Columbia
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 241]
Beckner's inequality for axially symmetric functions on $\mathbb{S}^4$ and $\mathbb{S}^6$

In this talk, we will show that the solutions for a Q-curvature type equation with a Paneitz operator on $\mathbb{S}^n$ in axially symmetric function spaces are constants when n=4, 6. As a result, we establish sharp Beckner's inequalities, which can be viewed as a higher order Moser-Trudinger-Onofri type inequality. We first reduce the equation to 1 dimension by axially symmetry and then study the coefficient of the solution in a suitable orthogonal expansion. I will also introduce some related open problems and point out the difficulties. It is a joint work with Juncheng Wei and Zikai Ye.

XINYANG LU, Lakehead University
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 241]
Regularity of equations from epitaxial growth

Epitaxial growth is a process where a thin film of material is deposited onto a much thicker substrate. It is currently widely used in precision manufacturing, due to its ability to produce high quality crystals. Since film and substrate are generally made of different materials, there is a mismatch between their material coefficients, hence the optimal distributions are generally non uniform. Their evolution is often modelled by high, e.g. fourth or even sixth, order PDEs. Analyzing their solutions is thus challenging. In this talk we will present recent results on solutions of several PDEs arising from expitaxial growth.

JEROME QUINTIN, University of Waterloo
[Saturday June 3 / samedi 3 juin, 15:40 – LMX 241]
Toward a non-perturbative understanding of a non-singular universe

The field of numerical relativity has grown tremendously over recent years and led to impressive results, especially in simulations of black hole mergers, which are now observed through gravitational waves. There is more and more interest in using numerical relativity to test modifications to general relativity that would represent new physics in strong gravity regimes, such as around black holes or in the early universe. For such new theories, the challenge is often finding a well-posed formulation of the set of partial differential equations that govern spacetime geometry. We are tackling this problem for a theory called the Cuscuton, a modified gravity theory that, among other things, admits perturbatively stable non-singular cosmological solutions. To test the solution in full (i.e., non-perturbatively) will require numerical relativity techniques. In this talk, I present our recent progress in this direction.

DANIEL SPECTOR, Taiwan Normal University
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 241]

CHONG WANG, Washington and Lee University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 241]
Periodic Minimizers of A Ternary Nonlocal Isoperimetric Problem

We study a two-dimensional ternary inhibitory system. The free energy functional combines an interface energy favoring micro-domain growth with a Coulomb-type long range interaction energy which prevents micro-domains from unlimited spreading. Here we consider a limit in which two species are vanishingly small, but interactions are correspondingly large to maintain a nontrivial limit. In this limit two energy levels are distinguished: the highest order limit encodes information on the geometry of local structures as a two-component isoperimetric problem, while the second level describes the spatial distribution of components in global minimizers. We provide a sharp rigorous derivation of the asymptotic limit, both for minimizers and in the context of Gamma-convergence. Geometrical descriptions of limit configurations are derived. The main difficulties are

hidden in the optimal solution of two-component isoperimetric problem: compared to binary systems, not only it lacks an explicit formula, but, more crucially, it can be neither concave nor convex on parts of its domain.

ERIC WOOLGAR, University of Alberta
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 241]
Uniqueness problems for quasi-Einstein equations

I will discuss some uniqueness problems for the Einstein equations and its close relatives, especially the quasi-Einstein equation (but also the Ricci flow equation). These problems are motivated by the study of black hole solutions of general relativity, but are all posed for metrics of Riemannian signature. The problems are partly or entirely open.

KAZUO YAMAZAKI, Texas Tech University
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 241]
Recent developments for convex integration on fluid PDEs

I will review recent developments on the technique of convex integration applied to PDEs in hydrodynamics (mainly stochastic ones) that has led to various non-uniqueness results in both deterministic and stochastic cases. Examples of equations include the Navier-Stokes equations, magnetohydrodynamics system, surface quasi-geostrophic equations, and transport (continuity) equation, etc.

DEPING YE, Memorial University of Newfoundland
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 241]
Mou He Fang Gai: A legend over thousands years

The study of Mou He Fang Gai (also known as the bicylinder) dated back to Archimedes, Hui Liu, Chongzhi Zu, Geng Zu etc. In particular, the old Chinese mathematicians Chongzhi Zu and Geng Zu took use of Mou He Fang Gai to find the explicit formula of the volume of 3-dimensional balls. This is one of the milestone results in the (Chinese) mathematical history.

In this talk, I will briefly explain how to use Mou He Fang Gai to find the formula for 3-dimensional ball. Motivated by the construction of Mou He Fang Gai, I will also talk about how to develop a new polarity (and hence a new family of convex bodies) for sets in the n-dimensional space. This new polarity naturally defines many useful notions parallel to those for convex bodies. In particular, I will explain how to get a new Blaschke-Santalo type inequality.

QI S. ZHANG, UC Riverside
[Saturday June 3 / samedi 3 juin, 16:20 – LMX 241]
Log gradient estimates of the heat equation on manifolds.

We will first review a number of log gradient estimates for the heat equation by Li-Yau, Hamilton and Perelman and their application in geometry and topology. Next we present a recent result showing a sharp Li Yau estimate for all compact manifolds and impossibility of sharp estimate for all noncompact manifolds, answering an open question by several people. Recent extension by X. Song, L. Wang, M. Zhu and Z will also be mentioned.

Group Symmetries and Equivariance in Algebra, Descent, Geometry, and Topology
Symétries de groupes et équivariance en algèbre, descente, géométrie et topologie

Org: Dorette Pronk, **Deni Salja** and/et **Geoff Vooys** (Dalhousie University)

This session will bring together researchers to learn from each other and share our relative perspectives on equivariance and symmetry in a wide diversity of fields, including algebraic geometry, algebraic topology, arithmetic geometry, category theory, differential and symplectic geometry, (equivariant) homotopy theory, Hopf algebras, (p-adic) representation theory, sheaf theory, stack theory, topological data analysis, topological complexity theory, and more.

Cette session réunira des chercheurs qui apprendront les uns des autres et partageront leurs perspectives relatives sur l'équivariance et la symétrie dans une grande diversité de domaines, y compris la géométrie algébrique, la topologie algébrique, la géométrie arithmétique, la théorie des catégories, la géométrie différentielle et symplectique, la théorie de l'homotopie (équivariante), les algèbres de Hopf, la théorie des représentations (p-adiques), la théorie des faisceaux, la théorie des faisceaux à valeurs dans une catégorie, l'analyse topologique des données, la théorie topologique de la complexité topologique, et plus encore.

Schedule/Horaire **Room/Salle: LMX 390**

Sunday June 4 / dimanche 4 juin

9:00 - 9:30	James Steele (University of Calgary), *Equivariant cohomology and the categorical local Langlands correspondence* (p. 95)
9:30 - 10:00	Nicole Kitt (University of Waterloo), *Characterization of Cofree Representations of $SL_n \times SL_m$* (p. 95)
10:00 - 10:30	Emily Cliff (Universite de Sherbrooke), *Principal 2-group bundles and applications* (p. 94)

Monday June 5 / lundi 5 juin

8:30 - 9:00	Jordan Watts (Central Michigan University), *Weak equivalences between action groupoids* (p. 96)
9:00 - 9:30	Jonathan Scott (Cleveland State University), *Algebraic Factorization of Chain Algebra Morphisms* (p. 95)
9:30 - 10:00	Jean-Baptiste Vienney (University of Ottawa) (p. 95)
10:00 - 10:30	Robin Cockett (University of Calgary), *Moore-Penrose Inverses in Dagger Categories* (p. 94)

Abstracts/Résumés

EMILY CLIFF, Université de Sherbrooke
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 390]
Principal 2-group bundles and applications

A 2-group is a categorical generalization of a group: it's a category with a multiplication operation which satisfies the usual group axioms only up to coherent isomorphisms. A smooth 2-group is a categorical generalization of a Lie group. I will define principal bundles for such a smooth 2-group, and provide classification results that allow us work concretely with explicit bicategories of 2-group bundles. I will discuss applications of these ideas to the study of string structures and to Chern-Simons theory (in progress). This talk is based on joint work with Dan Berwick-Evans, Laura Murray, Apurva Nakade, and Emma Phillips.

ROBIN COCKETT, University of Calgary
[Monday June 5 / lundi 5 juin, 10:00 – LMX 390]
Moore-Penrose Inverses in Dagger Categories

The notion of a Moore-Penrose inverse (M-P inverse) was introduced by Moore in 1920 and rediscovered by Penrose in 1955. The M-P inverse of a complex matrix is a special type of inverse which is unique, always exists, and can be computed using singular value decomposition. In a series of papers in the 1980s, Puystjens and Robinson studied M-P inverses more abstractly in the context of dagger categories. Despite the fact that dagger categories are now a fundamental notion in categorical quantum mechanics, the notion of a M-P inverse has not (to our knowledge) been revisited since their work. Thus, the purpose of this presentation is to recall and renew the study of M-P inverses in dagger categories.

(Joint work with Jean-Simon Lemay)

NICOLE KITT, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 390]
Characterization of Cofree Representations of $SL_n \times SL_m$

Given a finite dimensional representation V/k of a group G, we consider the space $k[V]^G$ of all polynomial functions which are invariant under the action of G. At its heart, invariant theory is the study of $k[V]^G$ and its interactions with $k[V]$. We are particularly interested in the situation where $k[V]$ is free as a $k[V]^G$-module, which is equivalent to V/G being smooth and the quotient map $V \to V/G$ behaving as nicely as possible. We call such representations *cofree*. The classification of cofree representations is a motivating problem for a field of research that has been active for over 70 years. In the case when G is finite, the Chevalley-Shephard-Todd theorem says that V is cofree iff G is generated by pseudoreflections. Several classifications of cofree representations have been found for certain connected reductive groups, but unlike the Chevalley-Shepard-Todd theorem, these results consist of a list of cofree representations, rather than a general group-theoretic characterization. In 2020, D. Edidin, M. Satriano, and S. Whitehead stated a conjecture which intrinsically characterizes irreducible cofree representations of connected semisimple groups and verified it for simple Lie groups and tori. In this talk, we will discuss this conjecture and the work towards verifying it for $\mathsf{SL}_n \times \mathsf{SL}_m$.

JONATHAN SCOTT, Cleveland State University
[Monday June 5 / lundi 5 juin, 9:00 – LMX 390]
Algebraic Factorization of Chain Algebra Morphisms

The algebraic factorization systems of Riehl provide for functorial solutions to the lifting problem in a given model category. Using a modified small objects argument, Riehl showed that any model category satisfying mild hypotheses has such a system. We will provide explicit constructions, using reasonably elementary techniques, of algebraic factorization systems for the category of chain (i.e. differential graded) algebras.

Our construction requires the use of strong homotopy morphisms in a fundamental way. Furthermore, we will discuss how our construc- tions may be carried out for algebras and coalgebras over an arbitrary Koszul operad/cooperad pair.

This is joint work with Kathryn Hess (EPFL) and Paul-Eugène Parent (U Ottawa).

JAMES STEELE, University of Calgary
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 390]
Equivariant cohomology and the categorical local Langlands correspondence

The p-adic local Langlands correspondence currently posits a relationship between sets of simple objects of $\mathbf{Rep}(G)$, the category of smooth representations of a connected, reductive, p-adic group G, with sets of so-called Langlands parameters. In this talk, we discuss a conjectural interpretation of this correspondence given by a Koszul-like, algebraic relationship between certain full subcategories of $\mathbf{Rep}(G)$ and the equivariant cohomology of a geometerization of Langlands parameters. Furthermore, we demonstrate the implications that the conjecture has for the p-adic analogue of the Kazhdan-Lusztig conjecture.

JEAN-BAPTISTE VIENNEY, University of Ottawa
[Monday June 5 / lundi 5 juin, 9:30 – LMX 390]

JORDAN WATTS, Central Michigan University
[Monday June 5 / lundi 5 juin, 8:30 – LMX 390]
Weak equivalences between action groupoids

A result of Pronk and Scull states that a weak equivalence between two representable orbifold groupoids is isomorphic to the composition of weak equivalences given by a "quotient functor" and an "inclusion functor". Here, the bicategory within which the result holds is the localisation of representable orbifold groupoids at weak equivalences. This result was proved in two steps: the first shows that the weak equivalence is isomorphic to an equivariant one, and the second is the decomposition into the two special functors. In this talk, we generalise this result to the bicategory of action Lie groupoids for Lie group actions that satisfy any subset of the following properties: free, locally free, transitive, compact, discrete, or proper. This is joint work with Carla Farsi and Laura Scull.

Hopf Algebras and Related Topics
Algèbres de Hopf et sujets connexes

Org: Yevgenia Kashina (DePaul University, Chicago), **Mikhail Kotchetov** (Memorial University), **Mitja Mastnak** (Saint-Mary's University) and/et **Yorck Sommerhäuser** (Memorial University)

A Hopf algebra is an algebra for which it is possible to define the tensor product of two modules. Hopf algebras are currently an area of very intense research, with applications ranging from conformal field theory to quantum computing. In addition to these, this session will include related topics such as tensor categories, quantum groups, algebraic groups, and Hopf orders.

Une algèbre de Hopf est une algèbre pour laquelle il est possible de définir le produit tensoriel de deux modules. Les algèbres de Hopf sont actuellement un domaine de recherche très intense, avec des applications allant de la théorie des champs conformes à l'informatique quantique. En plus de celles-ci, cette session inclura des sujets connexes tels que les catégories tensorielles, les groupes quantiques, les groupes algébriques et les ordres de Hopf.

Schedule/Horaire **Room/Salle: LMX 220**

Saturday June 3 — samedi 3 juin

8:00 - 8:50	Marcelo Aguiar (Cornell University, USA), *The Eckmann-Hilton argument in duoidal categories* (p. 98)
9:00 - 9:50	Miodrag Iovanov (University of Iowa, USA) (p. 99)
10:00 - 10:25	Kenny De Commer (Vrije Universiteit Brussel, Belgium), *Doi-Koppinen modules and quantized Harish-Chandra modules* (p. 98)
15:00 - 15:50	Jean-Simon Pacaud Lemay (Macquarie University, Australia), *Lifting Trace with Hopf Algebras and Hopf Monads* (p. 99)
16:00 - 16:25	Ellen Kirkman (Wake Forest University, USA), *McKay matrices for finite-dimensional Hopf algebras* (p. 99)
16:30 - 16:55	Kayla Orlinsky (University of Southern California, USA), *Second indicators of the fusion category $\mathcal{C}(G, H)$ where G is a coexeter group and H is a reflection subgroup* (p. 99)
17:00 - 17:25	Stefan Catoiu (DePaul University, USA), *Recent developments in the theory of generalized derivatives via algebra* (p. 98)
17:30 - 17:55	Bahram Rangipour (University of New Brunswick, Canada), *Toward the primary conjecture* (p. 100)

Sunday June 4 — dimanche 4 juin

8:00 - 8:50	Hongdi Huang (Rice University, USA), *Twisting of graded quantum groups and comodule algebras* (p. 99)
9:00 - 9:50	Xingting Wang (Howard University, USA), *Twisting Manin's universal quantum groups and comodule algebras* (p. 100)
10:00 - 10:25	Ryan Aziz (Université Libre de Bruxelles, Belgium), *Generalize Yetter-Drinfeld Modules and Center of Biactegories* (p. 98)
15:00 - 15:55	Sean Sanford (Ohio State University, USA), *Non-Split Tambara-Yamagami Categories over the Reals* (p. 100)
16:00 - 16:50	Rui Xiong (University of Ottawa, Canada), *Structure algebras, Hopf algebroids and oriented cohomology of a group* (p. 101)
17:00 - 17:50	Qing Zhang (Purdue University, USA), *Super-modular categories from near-group centers* (p. 101)

Monday June 5 — lundi 5 juin

8:00 - 8:50	Yilong Wang (BIMSA, China), *Modular tensor categories from SL(2,Z) representations* (p. 101)
9:00 - 9:25	Joost Vercruysse (Université Libre de Bruxelles, Belgium), *A Hopf category of Frobenius algebras* (p. 100)

Abstracts/Résumés

MARCELO AGUIAR, Cornell University
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 220]
The Eckmann-Hilton argument in duoidal categories

We will go over the basics of duoidal categories, illustrating with a number of examples. As monoidal categories provide a context for monoids, duoidal categories provide one for duoids and bimonoids. Our main goal is to discuss a number of versions of the classical Eckmann-Hilton argument which may be formulated in this setting. As an application we will obtain the commutativity of the cup product on the cohomology of a bimonoid with coefficients in a duoid, an extension of a familiar result for group and bialgebra cohomology.

The talk borrows on earlier work in collaboration with Swapneel Mahajan on the foundations of duoidal categories (2010). The main results are from ongoing work with Javier Coppola. We also rely on work of Richard Garner and Ignacio López-Franco (2016).

RYAN AZIZ, Université Libre de Bruxelles
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 220]
Generalize Yetter-Drinfeld Modules and Center of Biactegories

We study the notion of the E-center of bi-actegory $\mathcal{Z}_E(\mathcal{M})$ where $\mathcal{M}$ is a $(\mathcal{C},\mathcal{D})$-biactegory (or bimodule category) relative to an op-monoidal functor $E:\mathcal{C}\to\mathcal{D}$. We apply the theory to $\mathcal{M}={}_A\mathrm{Mod}$, $\mathcal{C}={}_H\mathrm{Mod}$, and $\mathcal{D}={}_K\mathrm{Mod}$, and $E\cong C\otimes_H -:{}_H\mathrm{Mod}\to{}_K\mathrm{Mod}$, where A is a (H,K)-bicomodule algebra and C is a (K,H)-bimodule coalgebra. Under the condition that A is an H-Galois object, we show that the E-center of ${}_A\mathrm{Mod}$ is equivalent to the category of generalized Yetter-Drinfeld modules as introduced by Canaepeel, Militaru, and Zhu, generalizing the similar well-known result for the usual Yetter-Drinfeld modules.

STEFAN CATOIU, DePaul University
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 220]
Recent developments in the theory of generalized derivatives via algebra

We outline a few recent developments in the theory of generalized derivatives: 1) the solution to the subject's main problem on the equivalence between the Peano and Riemann derivatives, going back to Khintchine in 1927 ; 2) the solution of the problem of classifying the equivalences between any two generalized Riemann derivatives, going back to Ash in 1967 ; 3) the solution to the GGR conjecture on the equivalence between the Peano and sets of generalized Riemann derivatives, formulated by Ginchev, Guerragio and Rocca in 1998 ; and 4) the solution to a question by G. Benkart in 2021, on the Leibniz Rule for generalized Riemann derivatives. All these recent proofs involved some sort of algebra: linear algebra, polynomial algebra, graded algebra, group algebra, and coalgebra. The talk is based on joint work with J. Marshall Ash, William Chin, Marianna Csörnyei and Hajrudin Fejzić.

KENNY DE COMMER, Vrije Universiteit Brussel
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 220]
Doi-Koppinen modules and quantized Harish-Chandra modules

A (left) Doi-Koppinen datum consists of a bialgebra H together with a right H-comodule algebra A and a left H-module coalgebra C. A Doi-Koppinen module is then a left A-module which is at the same time a right C-comodule, such that the module and comodule structure are compatible in a natural way. Natural Doi-Koppinen data can be constructed from right coideal subalgebras in bialgebras. In this talk, we will revisit the theory of Doi-Koppinen modules for particular coideal subalgebras obtained from Letzter's quantum symmetric pairs, and will show that the associated Doi-Koppinen modules provide a natural framework for the quantization of Harish-Chandra modules associated to real semisimple Lie groups. If we have time,

we will explain how in this setting, the Doi-Koppinen modules acquire a natural monoidal structure, based on a theorem due to Takeuchi. This is joint work with J.R. Dzokou Talla.

HONGDI HUANG, Rice University
[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 220]
Twisting of graded quantum groups and comodule algebras

One particualr interesting deformation of a Hopf algebra is its 2-cocycle twist. On another hand, a graded algebra can be deformated by its grade automorphisms, which is called Zhang twist. In this talk, we will introduce the sufficient conditions how to deform a Hopf algebra by Zhang twist. In addition, we will systematically describe a Zhang twist of a Hopf algebra as a 2-cocycle twist ; and a Zhang twist of a comodule algebra as a 2-cocycle twist over the Manin's universal quantum groups.

MIODRAG IOVANOV, University of Iowa, USA
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 220]

ELLEN KIRKMAN, Wake Forest University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 220]
McKay matrices for finite-dimensional Hopf algebras

Let H be a finite dimensional Hopf algebra over an algebraically closed field of characteristic zero with simple modules $\mathsf{S}_1, \ldots, \mathsf{S}_m$, and let V be a fixed H-module. The McKay matrix M_V of V encodes the multiplicities of each S_j as a composition factor of each $\mathsf{S}_i \otimes \mathsf{V}$. Steinberg showed that for $\mathsf{H} = \mathbb{C}G$ the eigenvalues and the eigenvectors of M_V are related to characters, and further results in characteristic p were obtained by Grinberg, Huang and Reiner. We prove general results about McKay matrices, their eigenvalues, and their (left and right) (generalized) eigenvectors by using the coproduct and the characters of simple and projective H-modules. We illustrate these results for the Drinfeld double D_n of the Taft algebra for n odd and $n \geq 3$. This is joint work with Georgia Benkart, Rekha Biswal, Van Nguyen, and Jieru Zhu.

JEAN-SIMON PACAUD LEMAY, Macquarie Universirty
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 220]
Lifting Trace with Hopf Algebras and Hopf Monads

A Hopf algebra H in a symmetric monoidal category $\mathbb{X}$ has the special ability of lifting many desirable structures and properties of $\mathbb{X}$ to $\mathsf{MOD}(H)$, the category of H-modules. Indeed, $\mathsf{MOD}(H)$ will be a symmetric monoidal category, and if $\mathbb{X}$ is closed, or star-autonomous, or even compact closed, then $\mathsf{MOD}(H)$ will be as well. The antipode of H plays a crucial role in lifting these structures. In this talk, I will explain how Hopf algebras also have the ability of lifting traces. Traced monoidal categories, introduced by Joyal, Street and Verity, are symmetric monoidal categories equipped with a trace operator, which generalizes the classical notion of the trace of matrices in linear algebra. Traced monoidal categories have many applications in mathematics, quantum foundations, and computer science. If $\mathbb{X}$ is a traced monoidal category, then for a Hopf algebra H, $\mathsf{MOD}(H)$ will be a traced symmetric monoidal category. In particular, this means that the trace of an H-module morphism is again an H-module morphism. We will also consider the special cases of compact closed categories (where the trace is given by duals), or when the monoidal product is a product (where the trace is given by fixpoints) or a coproduct (where the trace is given by iteration). We will also discuss how this fact also generalizes to the notion of Hopf monads, in the sense of Bruguières, Lack, and Virelizier.

This is joint work with Masahito Hasegawa, and is based on our paper: arXiv:2208.06529

KAYLA ORLINSKY, University of Southern California
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 220]
Second indicators of the fusion category $\mathcal{C}(G, H)$ where G is a coexeter group and H is a reflection subgroup

This is an ongoing joint project with Peter Schauenburg. In 2009, Guralnick and Montgomery showed that if G is a finite real reflection group, then $D(G)$–the Drinfel'd double of G over an algebraically closed field k of characteristic not 2–is totally orthogonal. That is, all irreps of $D(G)$ have indicator $+1$. Using the notation of [Schauenburg 2016], we explore several cases where the second indicator of the simple objects of the group-theoretical fusion category $\mathcal{C}(G, H)$ are all nonnegative where G is a finite coexeter group and H is a reflection subgroup of G.

BAHRAM RANGIPOUR, University of New Brunswick
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 220]
Toward the primary conjecture

Hopf cyclic cohomology was invented by A. Connes and H. Moscovici to compute the local index cocycle associated to a hypoelliptic operator on the frame bundle twisted by the group of diffeomorphisms. The goal was to compute the cocycle in the Gelfand-Fuks cohomology of formal vector fields. To the speaker's knowledge, the only computation so far is done by the inventors in degree 1 to show the index cocycle is 1. There is a conjecture that states that the cocycle is made of primary classes. Toward this direction we associate a sequence of coalgebras to the Lie algebra of formal vector fields on the Euclidean space . We also introduce a Hopf algebra that acts on all coalgebras in the sequence. We compute the Hopf cyclic cohomology of some of the coalgebras to make sure the path is the right one. This is a collaboration with Serkan Sutlu.

SEAN SANFORD, The Ohio State University
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 220]
Non-Split Tambara-Yamagami Categories over the Reals

In 1998, Tambara and Yamagami classified all split fusion categories with a certain simple set of fusion rules that occur naturally as categories of complex representations of finite groups. When taking real representations, irreducible representations can be real a.k.a. *split*, or they can be complex or quaternionic, a.k.a. *non-split*. For example, $\mathrm{Rep}_{\mathbb{R}}(Q_8)$ contains a quaternionic irreducible of dimension 4. In a recent paper with J. Plavnik and D. Sconce, we have extended the classification to now include such non-split irreducibles. I will give many examples, and along the way I will discuss some of the complications involved in working with fusion categories over the reall numbers.

JOOST VERCRUYSSE, Université Libre de Bruxelles
[Monday June 5 / lundi 5 juin, 9:00 – LMX 220]
A Hopf category of Frobenius algebras

A well-known result of Sweedler tells that the category of algebras can be enriched over coalgebras, by considering the universal measuring coalgebra between two algebras as the Hom-object between them. Another way of stating this result, is that the category of algebras can be given a semi-Hopf category structure. By a similar construction, one can build a universal measuring coalgebra $C(A, B)$ between any two Frobenius algebras A and B (being not just compatible with the algebra structure but also with their coalgebra (or Frobenius) structure). A remarkable observation is that in this way we do not just obtain a semi-Hopf category structure but even a Hopf category, meaning that there exists an anti-coalgebra morphism from $C(A, B)$ to $C(B, A)$ satisfying a natural antipode property. In particular, the universal acting bialgebra on a Frobenius algebra is always Hopf, which generalizes the known result that any (endo)morphism of Frobenius algebras is invertible.

This is based on joint works with Ana Agore and Alexey Gordienko, and with Paul Grosskopf.

A. Agore, A. Gordienko and J. Vercruysse, V-universal Hopf algebras (co)acting on Ω-algebras, Commun. Contemp. Math. 25 (2023), Paper No. 2150095, 40 pp.

E. Batista, S. Caenepeel and J. Vercruysse, Hopf categories, Algebr. Represent. Theory 19 (2016), 1173-1216.

P. Grosskopf and J. Vercruysse, Free and co-free constructions for Hopf categories, arXiv:2305.03120.

P. Grosskopf and J. Vercruysse, The Hopf category of Frobenius algebras, in preparation.

XINGTING WANG, xingting.wang@howard.edu
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 220]
Twisting Manin's universal quantum groups and comodule algebras

In this talk, we will discuss the homological properties invariant under Morita-Takeuchi equivalence. In particular, we consider the infinite coaction of the Manin's universal quantum groups on an AS-regular algebra. As a consequence, the AS-regularity is invariant under 2-cocycle twist. This is joint work with Hongdi Huang, Van C. Nguyen, Charlotte Ure, Kent B. Vashaw, and Padmini Veerapen.

YILONG WANG, Yanqi Lake Beijing Institute of Mathematical Sciences and Applications
[Monday June 5 / lundi 5 juin, 8:00 – LMX 220]
Modular tensor categories from SL(2,Z) representations

Modular data is an essential invariant of a modular tensor category, and they enjoy various algebraic properties such as rationality, congruence property and Galois symmetry. In this talk, we use the algebraic properties of modular data, or to be more precise, of the modular group representations to study modular tensor categories. As an example, we will talk about our result on the classification of transitive modular tensor categories and the symmetrization of congruence representations of SL(2,Z). This talk is based on joint works with Siu-Hung Ng, Samuel Wilson and Qing Zhang.

RUI XIONG, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 220]
Structure algebras, Hopf algebroids and oriented cohomology of a group

In this talk, we present our work on proving that the structure algebra of a Bruhat moment graph of a finite real root system is a Hopf algebroid with respect to the Hecke and the Weyl actions. We introduce new techniques and apply them to linear algebraic groups, generalized Schubert calculus, and the combinatorics of Coxeter groups and finite real root systems. Our results have interesting implications for the natural Hopf-algebra structure on the algebraic oriented cohomology of Levine-Morel and for computing the Hopf-algebra structure of "virtual cohomology" of dihedral groups $I_2(p)$, where p is an odd prime.

QING ZHANG, Purdue University
[Sunday June 4 / dimanche 4 juin, 17:00 – LMX 220]
Super-modular categories from near-group centers

A super-modular category is a unitary pre-modular category with Müger center equivalent to the symmetric unitary category of super-vector spaces. The modular data for a super-modular category gives a projective representation of the group: $\Gamma_\theta < \mathrm{SL}(2,\mathbb{Z})$. Adapting work of Ng-Rowell-Wang-Wen, Cho-Kim-Seo-You computed modular data from congruence representations of Γ_θ using the congruence subgroup theorem for super-modular categories of Bonderson-Rowell-Wang-Z and the minimal modular extension theorem of Reutter-Johnson-Freyd. They found two classes of previously unknown modular data for rank 10 super-modular categories. We show that these data are realized by modifying the Drinfeld centers of near-group fusion categories associated with the groups $\mathbb{Z}/6$ and $\mathbb{Z}/2 \times \mathbb{Z}/4$. This is based on joint work with Eric Rowell and Hannah Solomon.

Interaction of discrete and convex geometry with analysis and combinatorics
Interaction de la géométrie discrète et convexe avec l'analyse et la combinatoire

Org: Karoly Bezdek (University of Calgary) and/et **Ferenc Fodor** (University of Szeged, Hungary)

Discrete geometry studies configurations of geometric objects (such as packings and coverings, combinatorial and metric theory of polytopes, geometric algorithms, rigidity theory, and the geometry of numbers), which may often be studied by the theory of convex bodies. This field is further fueled by computational geometry. This scientific session is intended to be meeting place for senior and junior experts of geometry, geometric functional analysis, probability and combinatorics in order to interact and share their ideas about current problems, recent advances and emerging directions in discrete and convex geometry.

La géométrie discrète étudie les configurations d'objets géométriques (tels que les emballages et les couvertures, la théorie combinatoire et métrique des polytopes, les algorithmes géométriques, la théorie de la rigidité et la géométrie des nombres), qui peuvent souvent être étudiés à l'aide de méthodes issues de la théorie des corps convexes. Le domaine est également alimenté par son lien avec la géométrie computationnelle. Cette session scientifique se veut un lieu de rencontre pour les experts seniors et juniors de la géométrie, de l'analyse fonctionnelle géométrique, des probabilités et de la combinatoire afin d'interagir et de partager leurs idées sur les problèmes actuels, les avancées récentes et les directions émergentes en géométrie discrète et convexe.

Schedule/Horaire **Room/Salle: LMX 240**

Saturday June 3 — samedi 3 juin

15:00 - 15:30	Egon Schulte (Northeastern University, USA), *Skeletal Uniform Polyhedra* (p. 106)
15:30 - 16:00	Christian Bingane (Polytechnique Montreal), *Maximal perimeter of a convex small polygon* (p. 103)
16:00 - 16:30	Deping Ye (Memorial University), *The dual Minkowski problem for unbounded closed hypersurfaces* (p. 107)
16:30 - 17:00	Ted Bisztriczky (University of Calgary), *A COMBINATORIAL CONSTRUCTION OF BI-CYCLIC 4-POLYTOPES* (p. 103)
17:00 - 17:30	Barry Monson (University of New Brunswick), *The Grand Antiprism* (p. 104)
17:30 - 18:00	Karoly Bezdek (University of Calgary), *On totally separable packings* (p. 103)

Sunday June 4 — dimanche 4 juin

8:00 - 8:30	Alina Stancu (Concordia University), *On convex bodies with sections of prescribed volume* (p. 106)
8:30 - 9:00	Andriy Prymak (University of Manitoba), *Convex bodies of constant width with exponential illumination number* (p. 105)
9:00 - 9:30	Yiming Zhao (Syracuse University, USA), *The Minkowski problem in Gaussian probability space* (p. 107)
9:30 - 10:00	Andrii Arman (University of Manitoba), *Upper bounds on the chromatic number of low dimensional spaces* (p. 103)
10:00 - 10:30	Manuel Fernandez (GeorgiaTech, Atlanta, USA), *On the ℓ_0 Isoperimetry of Measurable Sets* (p. 103)
15:00 - 15:30	Brett Leroux (University of California at Davis, USA), *Wendel's theorem and the neighborliness of random polytopes* (p. 104)
15:30 - 16:00	Alexandra Szabo (University of Szeged, Hungary), *On the variance of the volume of random polytopes* (p. 106)
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17:00 - 17:30	Kinga Nagy (University of Szeged, Hungary), *Best and random approximations with generalized disc-polygons* (p. 105)
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Abstracts/Résumés

ANDRII ARMAN, University of Manitoba
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 240]
Upper bounds on the chromatic number of low dimensional spaces

Let $\chi(\mathbb{E}^n)$ denote the chromatic number of the Euclidean space $\mathbb{E}^n$, i.e., the smallest number of colors needed to color points of $\mathbb{E}^n$ so that no two points unit distance apart are of the same color.

In this talk I will present explicit constructions of colorings of $\mathbb{E}^n$ based on sublattice coloring schemes and establish some new upper bounds. For example, I will provide the construction for the following bounds: $\chi(\mathbb{E}^5) \leq 140$, $\chi(\mathbb{E}^n) \leq 7^{n/2}$ for $n \in \{6, 8, 24\}$, and $\chi(\mathbb{E}^n) \leq 3^n$ for all $n \leq 38$ and $n = 48, 49$.

This talk is based on a joint work with Andriy Bondarenko, Andriy Prymak, and Danylo Radchenko.

KAROLY BEZDEK, University of Calgary
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 240]
On totally separable packings

A packing by translates of a convex body in Euclidean d-space is called a totally separable packing in short, a TS-packing if any two members of the packing can be separated by a hyperplane which is disjoint from the interior of every member of the packing. TS-packings form a fundamental subfamily of the translative packings in Euclidean d-space. So, it is natural to ask: What do we know about them ? The talk surveys the relevant (recent) results.

CHRISTIAN BINGANE, Polytechnique Montreal
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 240]
Maximal perimeter of a convex small polygon

A small polygon is a polygon of unit diameter. Finding the maximal perimeter of a convex small polygon with a given number of sides is an open problem when the number of sides is a power of two. This presentation discusses recent advances in this problem.

TED BISZTRICZKY, University of Calgary
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 240]
A COMBINATORIAL CONSTRUCTION OF BI-CYCLIC 4-POLYTOPES

Let B(p,q,n) denote the convex hull of n evenly spaced points on the generalized trigonometric moment curve (cos(pt),sin(pt),cos(qt),sin(qt)), ranging between 0 and 2π,and p and q relatively prime positive integers. If n=pq and p=q-3 then there are purely geometrical conditions that yield the face lattice of B(p,q,n).

MANUEL FERNANDEZ, Georgia Institute of Technology
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 240]
On the ℓ_0 Isoperimetry of Measurable Sets

The Coordinate-Hit-and-run (CHAR) walk is a type of random walk over a measurable set, where at each step a random coordinate of the current point is re-sampled. In a work of Vempala and Laddha, the authors gave the first polynomial bound on the mixing rate of the CHAR walk over convex bodies. As part of their proof strategy, the authors introduced the notion of the ℓ_0 isoperimetric coefficient of a measurable set and provided a lower bound for the quantity in the case of axis-aligned cubes.

In this talk we will present some new results regarding the ℓ_0 isoperimetric coefficient of measurable sets. In particular we pin down the exact order of magnitude of the ℓ_0 isoperimetric coefficient of axis-aligned cubes and present a general upperbound of the ℓ_0 isoperimetric coefficient for any measurable set.

FERENC FODOR, University of Szeged, Hungary
[Sunday June 4 / dimanche 4 juin, 17:30 – LMX 240]
Asymptotic expansions for generalized random polygons

There has been quite a lot of work done recently in various generalized models of random polytopes in convex bodies. One such model is when one takes n independent identically distributed uniform random points from a suitable convex body and considers the intersection of all congruent closed balls that contain the points. The resulting intersection is called a random ball-polytope (disc-polygon in the plane). In this talk we discuss the behavior of the vertex number of random disc-polygons. We prove series expansions for the expectation of the vertex number and area of random disc-polygons depending on the degree of smoothness of the boundary of the convex disc. Joint work with N. Montenegro (University of Szeged, Hungary).

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BALAZS GRUNFELDER, University of Szeged, Hungary
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 240]
On asymptotic properties of generalized random polygons

Let L and K be convex discs. We say that K is L-convex if it is the intersection of all translates of L that contain K. We consider the following probability model: Assume that K is L-convex, and take n independent random points form K according to the uniform probability distribution. The intersection of all translates of L containing the points is a random L-polygon in K. In this talk, we present asymptotic bounds for the variance of the number of vertices and area of such random L-polygons under various geometric conditions on K and L. Joint work with Ferenc Fodor (University of Szeged, Hungary).

This research was supported by project TKP2021-NVA-09. Project no. TKP2021-NVA-09 has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-NVA funding scheme.

BRETT LEROUX, University of California, Davis
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 240]
Wendel's theorem and the neighborliness of random polytopes

A convex polytope is *k-neighborly* if every subset of at most k vertices is a face of the polytope. A well-known feature of random polytopes in high dimension is that they often have a surprisingly high degree of neighborliness. For example, it is known that Gaussian random polytopes are cd-neighborly w.h.p. for some constant $1 > c > 0$ when the number of vertices is proportional to the dimension. Furthermore, work of Donoho and Tanner and Vershik and Sporyshev shows that there is a threshold for the neighborliness of Gaussian random polytopes. We show that a similar thing happens when the vertices are i.i.d. according to an arbitrary absolutely continuous probability distribution on $\mathbb{R}^d$. As a concrete example, our result implies that if for each d in $\mathbb{N}$ we choose an arbitrary absolutely continuous probability distribution μ_d on $\mathbb{R}^d$ and then set P to be the convex hull of an i.i.d. sample of at most $n = 10d/9$ random points from μ_d, the probability that P is $(d/10)$-neighborly approaches one as $d \to \infty$. We will also give an example of a family of distributions which show that this result is close to best possible. The proof relies on a generalization of Wendel's theorem due to Wagner and Welzl.

This material is based upon work supported by the National Science Foundation under Grants CCF-1657939, CCF-1934568 and CCF-2006994.

BARRY MONSON, University of New Brunswick Fredericton
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 240]
The Grand Antiprism

Discovered by J. H. Conway and M. Guy in 1965, the *grand antiprism* $\mathcal{A}$ is (for some) the only uniform, convex 4-polytope which is non-Wythoffian. It has 100 vertices and is bounded by 300 regular tetrahedra along with 20 pentagonal antiprisms. The Wikipedia article on $\mathcal{A}$ has some beautiful pictures, and remarks that the symmetry group $S(\mathcal{A})$ of order 400 is the 'Ionic diminished Coxeter group $[[10, 2+, 10]]$'. I will explain how this description is ambiguous, perhaps even wrong (not knowing the intent of the authors of the article, as of April, 2023). We will give a presentation for $S(\mathcal{A})$, which unexpectedly relates to the regular map $\{10, 10 \,|\, 2\}$. And what does 'non-Wythoffian' mean, anyway ?

KINGA NAGY, University of Szeged, Hungary
[Sunday June 4 / dimanche 4 juin, 17:00 – LMX 240]
Best and random approximations with generalized disc-polygons

In this talk, we consider the asymptotic behaviour of the distance between a convex disc K with sufficiently smooth boundary, and its approximating n-gons, as the number of vertices tends to infinity. We consider two constructions: the best approximating inscribed n-gons with respect to several notions of distance ; and random inscribed n-gons obtained by taking the convex hull of n i.i.d. random points chosen from the boundary of K. The asymptotic behaviour of the area deviation of K and the n-gon depend in both cases on the same, geometric limit. The best and random approximating n-gons are defined similarly in the circumscribed case.

We generalize the existing results on linear and spindle convexity to the so-called L-convexity. In the case of inscribed L-polygons, we prove similar asymptotic formulas by generalizing the geometric limits. We also introduce a notion of L-convex duality and consider the properties of the dual disc, which results are then used to prove formulas in the circumscribed case.

Joint work with Viktor Vígh (University of Szeged, Hungary).

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ANDRIY PRYMAK, University of Manitoba
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 240]
Convex bodies of constant width with exponential illumination number

Borsuk's number $f(n)$ is the smallest integer such that any set of diameter 1 in the n-dimensional Euclidean space can be covered by $f(n)$ sets of smaller diameter. Currently best known asymptotic upper bound $f(n) \leq (\sqrt{3/2}+o(1))^n$ was obtained by Shramm (1988) and by Bourgain and Lindenstrauss (1989) using different approaches. Bourgain and Lindenstrauss estimated the minimal number $g(n)$ of open balls of diameter 1 needed to cover a set of diameter 1 and showed $1.0645^n \leq g(n) \leq (\sqrt{3/2}+o(1))^n$. On the other hand, Schramm used the connection $f(n) \leq h(n)$, where $h(n)$ is the illumination number of n-dimensional convex bodies of constant width, and showed $h(n) \leq (\sqrt{3/2}+o(1))^n$. The best known asymptotic lower bound on $h(n)$ is subexponential and is the same as for $f(n)$, namely $h(n) \geq f(n) \geq c^{\sqrt{n}}$ for large n established by Kahn and Kalai with $c \approx 1.203$ (1993) and by Raigorodskii with $c \approx 1.2255$ (1999). In 2015 Kalai asked if an exponential lower bound on $h(n)$ can be proved.

We show $h(n) \geq (\cos(\pi/14)+o(1))^{-n}$ by constructing the corresponding n-dimensional bodies of constant width, which answers Kalai's question in the affirmative. The construction is based on a geometric argument combined with a probabilistic lemma establishing the existence of a suitable covering of the unit sphere by equal spherical caps having sufficiently separated centers. The lemma also allows to improve the lower bound of Bourgain and Lindenstrauss to $g(n) \geq (2/\sqrt{3}+o(1))^n \approx 1.1547^n$.

The talk is based on a joint work with Andrii Arman and Andriy Bondarenko.

EGON SCHULTE, Northeastern University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 240]
Skeletal Uniform Polyhedra

A skeletal polyhedron in ordinary space is a finite or infinite discrete structure made up of finite or infinite polygons as faces, with two faces on each edge and a circular vertex-figure at each vertex. Finite faces can be planar or skew, and infinite faces can be linear, zigzag, or helical. A skeletal polyhedron is said to be uniform if its faces are (finite or infinite) regular polygons and its geometric symmetry group is transitive on the vertices. The classification of arbitrary uniform skeletal polyhedra is a rather challenging open problem, but partial results are known. The convex uniform polyhedra are precisely the Archimedean solids and the prisms and anti-prisms. The classification of the finite uniform polyhedra with planar (convex or star-polygon) faces was essentially obtained in a classical paper by Coxeter, Longuet-Higgins and Miller in 1954, although the completeness of the enumeration was only proved years later, independently, by Skilling and Har'El. We explain how variants of Wythoff's construction applied to the regular or chiral skeletal polyhedra in ordinary space can be exploited to produce highly symmetric, vertex-transitive skeletal polyhedra, which in many cases are new uniform polyhedra. We describe the blueprint for the construction and discuss interesting examples including new skeletal snub polyhedra. This is joint work with Abigail Williams and Tomas Skacel.

ALINA STANCU, Concordia University
[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 240]
On convex bodies with sections of prescribed volume

Part of a larger project with several collaborators, we are studying how certain measurements of non-central sections of a convex body determines uniquely the convex body. Under extra hypotheses, we will show some characterizations of convex bodies in the Euclidean n-space whose $(n-1)$-dimensional sections tangent to a strictly, smooth, compact convex set contained in their interior have equal volume.

ALEXANDRA SZABO, University of Szeged, Hungary
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 240]
On the variance of the volume of random polytopes

We prove an asymptotic upper bound on the variance of the weighted volume of random polytopes which are generated by n independent random points selected from a d-dimensional convex body K according to a certain prescribed probability distribution. We only require K to have relatively weak smoothness properties. Using polar duality we convert these results into asymptotic upper bounds on the variance of the mean width of circumscribed random polyhedral sets about K. Joint work with Ferenc Fodor (University of Szeged, Hungary).

Supported by the UNKP-22-3-SZTE-454 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund. This research was also supported by project TKP2021-NVA-09. Project no. TKP2021-NVA-09 has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-NVA funding scheme.

VIKTOR VIGH, University of Szeged
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 240]
On random spherical disc-polygons

In 2017 Bárány, Hug, Reitzner and Schneider studied random spherical polytopes that are the spherical convex hull of n independent, uniform random points chosen from a half-sphere. They proved that expectation of the number of facets tends to

a constant c_d that depends only on the dimension (as $n \to \infty$). In 2020 Fodor showed that if we choose independent uniform random points from a unit ball, then the expected number of the facets of the generated uniform random ball-polytope also tends to the constants c_d in any dimension. In this talk we connect these two results in the case when $d = 2$, we study random spherical disc-polygons in a spherical cap of appropriate size, and show that expectation of the number of the edges tends to $c_2 = \pi^2/2$. We also extend the result to a more general case, where we choose the radnom points from a spherical convex disc with C^2 smooth boundary.

This is a joint work with Kinga Nagy.

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DEPING YE, Memorial University of Newfoundland

[Saturday June 3 / samedi 3 juin, 16:00 – LMX 240]

The dual Minkowski problem for unbounded closed hypersurfaces

The classical Minkowski problem deals with the characterization of the surface area measure for convex bodies. This problem has been extensively studied in literature and has found fundamental applications in many areas, such as analysis, PDEs, etc. This problem has been extended to various settings, such as the dual Minkowski problem.

An important notion, in analysis, probability, differential geometry, algebraic geometry, singularity theory etc, is the unbounded convex hypersurface, which behaves quite different from its compact relative. Hence, understanding the geometric, algebraic, topological properties for unbounded convex hypersurfaces is in great demand. Among those important topics are the Minkowski type problems for unbounded convex hypersurfaces.

In this talk, I will present some recent progress on the Minkowski type problems for unbounded closed hypersurfaces with concentration on the dual Minkowski problem. I will talk about the setting of this problem and the existence of solutions to this problem.

YIMING ZHAO, Syracuse University

[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 240]

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. Lack of homogeneity and translation invariance make this problem fundamentally different from the classical problem. We will discuss existence results (in all dimensions) as well as uniqueness results (in dimension 2). This is based on joint works with Yong Huang, Dongmeng Xi, and with Shibing Chen, Shengnan Hu, Weiru Liu.

Interplay Between Analysis and Convexity
Interaction entre l'analyse et la convexité

Org: Michael Roysdon (ICERM, Brown), **Deping Ye** (Memorial University) and/et **Yiming Zhao** (Syracuse)

The field of Convex Geometric Analysis is one which has become very rich in recent years owing to its unique blend of the fields of Convex Geometry, Functional Analysis, Harmonic Analysis, PDEs and Probability. Convex Geometric Analysis concerns the study of convex bodies in finite dimensional normed spaces and linear invariants associated to them. Many problems of isoperimetric type (Busemann-Petty Problem, Mahler's conjecture, affine isoperimetric problems, and Brunn-Minkowski type inequalities) and PDEs of Monge-Ampère (Minkowski problems) are actively studied. This session will include reseachers employing methods from functional analysis, PDEs, calculus of variations, optimal transport theory and probability to solve these naturally occurring geometry problems.

Le domaine de l'analyse géométrique convexe est devenu très riche ces dernières années en raison de son mélange unique des domaines de la géométrie convexe, de l'analyse fonctionnelle, de l'analyse harmonique, des EDP et des probabilités. L'analyse géométrique convexe concerne l'étude des corps convexes dans les espaces normés de dimension finie et des invariants linéaires qui leur sont associés. De nombreux problèmes de type isopérimétrique (problème de Busemann-Petty, conjecture de Mahler, problèmes isopérimétriques affines, et inégalités de type Brunn-Minkowski) et EDP de Monge-Ampère (problèmes de Minkowski) sont activement étudiés. Cette session comprendra des chercheurs et chercheuses qui utilisent des méthodes de l'analyse fonctionnelle, des EDP, du calcul des variations, de la théorie du transport optimal et des probabilités pour résoudre ces problèmes de géométrie naturelle.

Schedule/Horaire — Room/Salle: LMX 418

Sunday June 4 — dimanche 4 juin

8:30 - 9:00	Almut Burchard (University of Toronto), *On pointwise montonicity of heat kernels* (p. 109)
9:00 - 9:30	Károly Bezdek (University of Calgary), *The Kneser-Poulsen conjecture for uniform contractions revisited* (p. 109)
9:30 - 10:00	Joshua Flynn (McGill University), *Hardy Inequalities and Mean Convex Domains* (p. 110)
10:00 - 10:30	Min Chen (McGill University), *IN-HOMOGENEOUS GAUSS CURVATURE FLOWS* (p. 110)
15:00 - 15:30	Zengle Zhang (Chongqing University of Arts and Sciences), *The (φ, ψ) Orlicz mixed affine and geominimal surface areas* (p. 112)
15:30 - 16:00	Beatrice-Helen Vritsiou (University of Alberta), *The Illumination Conjecture for convex bodies with many symmetries* (p. 111)
16:00 - 16:30	Zhen Shuang (Memorial University of Newfoundland), *Weighted Laplacian Evolution Equation and Signal Decomposition* (p. 111)
16:30 - 17:00	Wen Ai (Memorial University of Newfoundland), *The L_p dual Minkowski problem for unbounded closed convex sets* (p. 109)
17:00 - 17:30	Chengjun Yue (Memorial University of Newfoundland), *A cartoon+texture image decomposition based on interpolation spaces* (p. 112)

Monday June 5 — lundi 5 juin

8:30 - 9:00	Jiazu Zhou (Southwest University), *Isoperimetric inequalities for mean curvature integrals* (p. 112)
9:00 - 9:30	Wanjun Ai (Southwest University), *A Geometric Constructive Proof for the 2D Discrete Minkowski Problem* (p. 109)
9:30 - 10:00	Julián Haddad (Universidad de Sevilla), *Higher-order Petty's projection inequality* (p. 110)
10:00 - 10:30	Dylan Langharst (Kent State University) (p. 111)
15:00 - 15:30	Ferenc Fodor (University of Szeged), *A central limit theorem for the area of random disc-polygons* (p. 110)
15:30 - 16:00	Sergii Myroshnychenko (Lakehead University), *How far apart can centroids be ?* (p. 111)

Interplay Between Analysis and Convexity
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16:00 - 16:30	Xia Zhou (Memorial University of Newfoundland), *On the optimal Orlicz norms and the general dual Musielak Orlicz-Minkowski problems* (p. 113)
16:30 - 17:00	Fang Hong (McGill University), *Sharpened Minkowski Inequality in Cartan-Hadamard Spaces* (p. 111)
17:00 - 17:30	Fanheng Xu (Memorial University of Newfoundland), *Geometric Sharp Sobolev-type Principle for The Graphic Submanifolds of Euclidean Space* (p. 112)

Abstracts/Résumés

WANJUN AI, Southwest University
[Monday June 5 / lundi 5 juin, 9:00 – LMX 418]
A Geometric Constructive Proof for the 2D Discrete Minkowski Problem

The 2-dimensional discrete Minkowski problem seeks to determine the necessary and sufficient conditions for the existence of a polygon in R^2 with n facets, whose outer unit normals are $u_1, u_2, \ldots, u_n \in S^1$ and such that the facet whose outer unit normal is u_i has length a_i, where $a_1, a_2, \ldots, a_n > 0$. Minkowski solved this problem in 1897 using a variational argument. In this talk, we will present a geometric constructive proof based on special reflections, which offers new insights into the problem and proposes the study of a new type of flow on 2-dimensional polygons.

WEN AI, Memorial University of Newfoundland
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 418]
The L_p dual Minkowski problem for unbounded closed convex sets

The Brunn-Minkowski theory for bounded closed convex sets is the core in convex geometry, especially the study on the Minkowski problem. From the classical Minkowski problem to the recent L_p dual Minkowski problem, the past century has witnessed the great development on the Minkowski type problems. The significance of the Minkowski type problems can be revealed in other areas, for instance, differential geometry and PDEs. The unbounded closed convex sets have proved to be important in differential geometry, PDEs, singularity theory and commutative algebra. This triggers the study of the corresponding geometric theory for unbounded closed convex sets, with particular interest on the Minkowski type problems.

In this talk, I will talk about my recent work on the L_p dual Brunn-Minkowski theory for unbounded closed convex sets. In particular, I will explain the (p, q)-th dual curvature measure for unbounded closed convex sets, and present an existence and uniqueness of solution to such L_p dual Minkowski problem in the unbounded setting.

KÁROLY BEZDEK, University of Calgary
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 418]
The Kneser-Poulsen conjecture for uniform contractions revisited

The Kneser-Poulsen conjecture (1955) states that if a finite set of (not necessarily congruent) balls in the Euclidean d-space is rearranged so that the distance between each pair of centers does not increase, then the area of the union does not increase, and the area of the intersection does not decrease. This was proved for $d = 2$ by K. Bezdek and R. Connelly in 2002. The Kneser-Poulsen conjecture is still open for all $d > 2$. Consider the following special case. Take finitely many congruent balls in the Euclidean d-space and reposition them (without changing their radius) by applying a uniform contraction to their centers. Here a uniform contraction maps the first set of centers onto the second set of centers such that the pairwise distances in the first set of centers are larger than or equal to all pairwise distances in the second set of centers. The lecture surveys the progress towards a proof of the Kneser-Poulsen conjecture for uniform contractions of congruent balls.

Interplay Between Analysis and Convexity
Interaction entre l'analyse et la convexité

ALMUT BURCHARD, University of Toronto
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 418]
On pointwise montonicity of heat kernels

The fact that the heat kernel $K_t(x, y)$ on the standard sphere decreases with the distance between the points x and y has important consequences in Probability and Functional Analysis. In a recent paper, Alonso-Oran, Chamizo, Mas, and Martinez asked, *What are the pointwise monotonicity properties of the heat kernel on a general Riemannian manifold ?* [See arXiv:1807.11072, Section 1.] I will describe current work with Angel Martinez on metrics on compact manifolds for which the heat kernel decreases monotonically as y moves along a minimal geodesic emanating from x. We prove that such metrics are extremely rare, while also providing a new example.

MIN CHEN, McGill University
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 418]
IN-HOMOGENEOUS GAUSS CURVATURE FLOWS

We consider the flow of convex hypersurfaces in Euclidean space R^{n+1} under the in-homogeneous speed functions of Gauss curvature. We establish the existence and convergence of the flow to a limit which is the round sphere (after rescaling) under appropriate conditions of the speed functions. This generalized the celebrated results on Gauss curvature flow by Andrews-Guan-Ni and Brendle-Choi-Daskalopoulos. This is joint work with Prof.Pengfei Guan and Jiuzhou Huang.

JOSHUA FLYNN, CRM/ISM, McGill University
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 418]
Hardy Inequalities and Mean Convex Domains

In this talk we present on our recent results on sharp Hardy integral identities and inequalities where the weights are in terms of the distance function to the boundary of a domain. The identities are used to address the existence of minimizers for the corresponding inequalities on weakly mean convex domains. For less regular domains, we obtain Hardy identities and inequalities in terms of the mean distance function to the boundary. This is a joint work with N. Lam and G. Lu.

FERENC FODOR, University of Szeged, Hungary
[Monday June 5 / lundi 5 juin, 15:00 – LMX 418]
A central limit theorem for the area of random disc-polygons

We consider the following probability model of random disc-polygons. Let K be a convex disc in the Euclidean plane with at least C^2_+ smooth boundary (twice continuously differentiable with everywhere positive curvature). Fix $r > 0$ such that it is larger than the maximum radius of curvature of the boundary of K. Take n independent random points from K according to the uniform probability distribution. Let K^r_n be the intersection of all radius r closed circular discs that contain the random points. This object is called a (uniform) random disc-polygon, and it is known to be contained in K. Various asymptotic properties of K^r_n (as $n \to \infty$) have been determined before, including an asymptotic formula for the expectation of the area of K not covered by K^r_n, and also lower and upper bounds of matching orders of magnitude (in n) for the variance of the area of K^r_n. In this talk we present a quantitative central limit theorem for the area of K^r_n based on Stein's method. Joint work with Dániel Papvári (Szeged, Hungary).

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Interplay Between Analysis and Convexity
Interaction entre l'analyse et la convexité

JULIÁN HADDAD, Universidad de Sevilla
[Monday June 5 / lundi 5 juin, 9:30 – LMX 418]
Higher-order Petty's projection inequality

In 1970 Schneider defined and studied the higher order difference body $D^\ell K \subseteq \mathbb{R}^{nm}$ of a convex body $K \subseteq \mathbb{R}^n$. Inspired by the connection of the difference body and the projection body through the covariogram function, we define the higher-order projection body and prove the corresponding Petty projection inequality. The result uses a volume-increasing fiber symmetrization method.

(joint work with D. LANGHARST, E. PUTTERMAN, M. ROYSDON AND D. YE)

FANG HONG, McGill University
[Monday June 5 / lundi 5 juin, 16:30 – LMX 418]
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 recent paper by M. Ghomi and J. Spruck, in which they generalized Minkowski inequality to general spaces with non-positive curvature via harmonic mean curvature flow. We will further discuss sharper inequality we get based on their results.

DYLAN LANGHARST, Kent State University
[Monday June 5 / lundi 5 juin, 10:00 – LMX 418]

SERGII MYROSHNYCHENKO, Lakehead University
[Monday June 5 / lundi 5 juin, 15:30 – LMX 418]
How far apart can centroids be ?

The orthogonal projection of the centroid (barycenter, center of mass) of a convex body K onto a hyperplane H, and the centroid of projection of K onto H coincide if K is centrally-symmetric. In general, this is not the case for non-symmetric convex bodies. In this talk, we investigate how far apart these points can be with respect to the width in the direction of the segment connecting them. The optimizers are described as well. The talk is based on the joint work with K. Tatarko and V. Yaskin (https://arxiv.org/abs/2212.14456).

ZHEN SHUANG, Memorial University of Newfoundland
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 418]
Weighted Laplacian Evolution Equation and Signal Decomposition

We show the existence of solutions for new types of weighted Laplacian wave equations and their applications in signal processing in which a signal is decomposed into four parts. The presence of solutions is proved by the Faedo-Galerkin method. The spectrum and decomposition of a signal are created through the discrete solutions of the equations in Matlab. Fractional order Laplacian and fractional order derivatives are expressed explicitly in the introduced equations, so it is easy to implement in Matlab.

BEATRICE-HELEN VRITSIOU, University of Alberta
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 418]
The Illumination Conjecture for convex bodies with many symmetries

We will show how to verify the Hadwiger-Boltyanski Illumination Conjecture (along with its equality cases) for 1-symmetric convex bodies of all dimensions (that is, convex bodies with the symmetries of the cube) and some cases of 1-unconditional convex bodies as well (that is, convex bodies with the symmetries of a rectangular box).

This is joint work with Wen Rui Sun.

FANHENG XU, Memorial University
[Monday June 5 / lundi 5 juin, 17:00 – LMX 418]
Geometric Sharp Sobolev-type Principle for The Graphic Submanifolds of Euclidean Space

I will present a recently established sharp Sobolev-type principle for a compact n-dimensional graphic submanifold (Σ, g) of $\mathbb{R}^{n+m}$. This principle was established using a positive smooth function f on Σ and the absolute value of the determinant of g. We demonstrate that the principle holds with equality when f is constant on Σ, $G = 1$ on $\partial\Sigma$, and Σ is a round ball in $\mathbb{R}^n$. Additionally, the inequality yields a sharp isoperimetric inequality for graphic submanifolds of Euclidean space with the unit metric determinant. This work was done in collaboration with Professor J. Xiao.

CHENGJUN YUE, Memorial University of Newfoundland
[Sunday June 4 / dimanche 4 juin, 17:00 – LMX 418]
A cartoon+texture image decomposition based on interpolation spaces

Image decomposition is referred to separating a given image into multiple layers of components with different characteristics. That is an essential problem in image processing since usually there is a need for extracting or modifying specific geometric structures of an image before further analysis. We focus on the decomposition of image f

$$f = u + v$$

where u is a piecewise constant component and v is an oscillation component. When f is a smooth image contaminated by noise, it comes back to the image-denoising model.

One of the typical methods for achieving this target is the variational method. From the famous (BV, L^2) decomposition, inspired by the $(BV, B\dot{M}O^{\alpha})$ and $(BV, \dot{W}^{\alpha,p})$ decomposition, we establish a new model $(BV, \dot{W}^{\alpha,p,\infty})$ for image decomposition.

ZENGLE ZHANG, Chongqing University of Arts and Sciences
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 418]
The (φ, ψ) Orlicz mixed affine and geominimal surface areas

The affine surface area is one of the central notions in the Brunn-Minkowski theory for convex bodies. Its special properties make the affine surface area very useful in the valuation theory, approximation of convex bodies by polytopes, affine isoperimetric inequalities, etc. The geominimal surface area is closely related to the affine surface area, and can be used to connect various geomtrices such as affine geometry, Minkowski geometry and relative geometry. It natrually leads to the fundamental object: Petty body. In this talk, we will present the (φ, ψ) Orlicz mixed affine and geominimal surface areas, and discuss their related properties, such as homogeneity, affine invariance, affine isoperimetric inequalities and continuity.

JIAZU ZHOU, Southwest University, China
[Monday June 5 / lundi 5 juin, 8:30 – LMX 418]
Isoperimetric inequalities for mean curvature integrals

The classical isoperimetric problem asserts that the ball has the maximum volume among domains with the given surface area in the n-dimensional Euclidean space. The isoperimetric problem is equivalent to the isoperimetri inequality that contains the

volume and the surface area of the domain. We try to study the isoperimetric inequalities for mean curvature integrals with the smooth boundary assumption for the domain in the n-dimensional Euclidean space.

XIA ZHOU, Memorial University of Newfoundland

[Monday June 5 / lundi 5 juin, 16:00 – LMX 418]

On the optimal Orlicz norms and the general dual Musielak Orlicz-Minkowski problems

As one of the cornerstones of the classical Brunn-Minkowski theory for convex bodies, the Minkowski problem plays a crucial role not only in convex geometry, but also in other related fields, such as, differential geometry, PDEs and optimal transport.

In this talk, a new Minkowski-type problem will be introduced, which involves the homogeneous general dual volume. I will talk about how to derive the corresponding general dual Musielak-Orlicz curvature measures. The characterization problems to those measures, i.e., the general dual Musielak Orlicz-Minkowski problem, will be discussed and an existence and uniqueness of solutions to such Minkowski problems will be presented.

Mathematical Modelling of Ecological, Evolutionary and Infectious Disease Dynamics
Modélisation mathématique de la dynamique des maladies écologiques, évolutives et infectieuses

Org: Jude Dzevela Kong (York University) and/et **Stacey Smith ?** (University of Ottawa)

Infectious diseases can have several drivers, including societal ones, as well as ecological and evolutionary forces acting on host-pathogen systems and interfaces. This highly multidisciplinary session will bring together researchers working on different (sub-)fields of ecological, evolutionary, and infectious disease dynamics to understand the interplay of the factors underlying disease emergence and modelling of the widespread influence of humans on host and pathogen evolutionary trajectories. The accepted abstracts will be those that use quantitative methods to study ecological, evolutionary or infectious disease dynamics.

Les maladies infectieuses peuvent avoir plusieurs moteurs, y compris des moteurs sociétaux, ainsi que des forces écologiques et évolutives agissant sur les systèmes et interfaces hôte-pathogène. Cette session hautement multidisciplinaire réunira des chercheurs et des chercheuses travaillant sur différents (sous-)domaines de la dynamique de l'écologie, de l'évolution et des maladies infectieuses afin de comprendre l'interaction des facteurs qui sous-tendent l'émergence des maladies et la modélisation de l'influence généralisée de l'homme sur les trajectoires évolutives des hôtes et des pathogènes. Les résumés acceptés seront ceux qui utilisent des méthodes quantitatives pour étudier la dynamique des maladies écologiques, évolutives ou infectieuses.

Schedule/Horaire **Room/Salle: LMX 242**

Sunday June 4 — dimanche 4 juin

8:00 - 8:30	Jude Kong (York University), *Mpox dynamic model: incorporating adaptive behavioural changes, control strategies in the MSM community & under-reporting.* (p. 116)
8:30 - 9:00	Zahra Movahedi Nia (York University), *Predicting Hotspots of Marburg Virus in Africa using Ecological Niche Modeling* (p. 118)
15:00 - 15:30	Junling Ma (York University), *Estimating the Effect of Contact Tracing During the Early State of an Epidemic* (p. 117)
15:30 - 16:00	Francis Anokye (Memorial), *Newfoundland and Labrador Two-Peaked BA.1 Wave* (p. 115)
16:00 - 16:30	Tyler Meadows (Queen's), *Microbial Competition in a Serial Transfer Culture* (p. 118)
16:30 - 17:00	Xiaoying Wang (Trent), *Studying the fear effect in a predator-prey system with apparent competition* (p. 120)
17:00 - 17:30	Stacey Smith ? (Ottawa), *Modelling mutation in equine infectious anemia virus infection suggests a path to viral clearance with repeated vaccination* (p. 119)
17:30 - 18:00	Carly Rozins (York University), *Why Are Bat-Borne Viruses So Deadly ?* (p. 118)

Monday June 5 — lundi 5 juin

8:00 - 8:30	Michael Li (University of Alberta), *Nonidentifiability in Parameter Estimation of Simple and Complex Epidemic Models* (p. 117)
8:30 - 9:00	Woldegebriel Assefa Woldegerima (York University), *Modelling the impact of temperature change and rainfall on the spread of vector-borne diseases: malaria as a case study* (p. 120)
9:00 - 9:30	Sonia Gazeau (Université de Montréal), *Constructing virtual patient populations to understand immune responses in immunosuppressed and cancer patients with COVID-19* (p. 116)
9:30 - 10:00	Chinwendu Madubueze (Federal University of Agriculture, Makurdi), *Modelling transmission dynamics of Lassa fever transmission with environmental pathway transmission* (p. 117)
10:00 - 10:30	Pei Yuan (York University), *Will the vaccination strategies for monkeypox prevent outbreaks at gatherings ? —a case study in Canada* (p. 120)
15:00 - 15:30	Elaheh Abdollahi (York University), *Assessing control strategies and timelines for Mycobacterium tuberculosis elimination, Nunavut as a case study* (p. 115)
15:30 - 16:00	Qing Han (York University), *Evaluation of the impact on pertussis transmission dynamics of adult and maternal boosting programs in the province of Ontario* (p. 116)
16:00 - 16:30	Alison Simmons (University of Toronto), *Pneumococcal Transmission Dynamics in Canada: 2010–2019* (p. 119)

Mathematical Modelling of Ecological, Evolutionary and Infectious Disease Dynamics
Modélisation mathématique de la dynamique des maladies écologiques, évolutives et infectieuses

16:30 - 17:00	Dan Cooney (University of Pennsylvania), *Long-Time Behavior of a PDE Replicator Equation for Multilevel Selection in Group-Structured Populations* (p. 115)
17:00 - 17:30	Blessing Ogbuokiri (York University), *Vaccine Hesitancy Hotspots in Africa: An Insight From Geotagged Twitter Posts* (p. 118)
17:30 - 18:00	Yogita Sharma (University of Victoria), *Effect of stochasticity and spatial structure on homing-based gene drive spread* (p. 119)

Abstracts/Résumés

ELAHEH ABDOLLAHI, York University
[Monday June 5 / lundi 5 juin, 15:00 – LMX 242]
Assessing control strategies and timelines for Mycobacterium tuberculosis elimination, Nunavut as a case study

Tuberculosis (TB) continues to have a disproportionate impact on Inuit communities in Canada, with reported rates of active TB that are over 300 times higher than those of Canadian-born, non-Indigenous individuals. The Inuit Tuberculosis Elimination Framework aims to reduce the incidence of active TB by at least 50

FRANCIS ANOKYE, Memorial University of Newfoundland
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 242]
Newfoundland and Labrador Two-Peaked BA.1 Wave

Before establishing the Omicron variant, Canada's province, Newfoundland and Labrador (NL), pursued a containment strategy and reported more than 150 weekly SARS-CoV-2 cases only twice out of 98 weeks. Ninety-seven (97) weekly cases were reported in the first full week after establishing the BA.1 (Omicron) variation, and over 150 cases were reported each week for the next 12 weeks. There are three months (December 15, 2021 - March 17, 2022) when both the BA.1 variant is spreading, and most individuals with at least one COVID-19 symptom are eligible for testing at the NL provincial sites. Analysis of epidemiological data reported during this period is critical to understanding SARS-CoV-2 spread in the province. Therefore, we fit an integrated Bayesian-based and machine learning framework, particle Markov-chain Monte Carlo, and a stochastic compartmental model to the epidemiological data. During this period, the trend in reported cases has two peaks: first, in early January, corresponding to the implementation of stricter non-pharmaceutical interventions (NPIs), and second, in mid-March, corresponding to when most symptomatic residents lost eligibility for COVID-19 testing at local sites. We use our parameterized epidemiological model to explore counterfactual scenarios and find that stricter NPIs and high vaccination rates could have prevented 28,897 SARS-CoV-2 cases. Our analysis suggests that implementing stricter NPIs in NL in early 2022 may have led to a switch from an increasing to a decreasing trend in SARS-CoV-2 cases. We know of little other evidence suggesting that stricter NPIs can have this effect on the highly transmissible Omicron variant.

DAN COONEY, University of Pennsylvania
[Monday June 5 / lundi 5 juin, 16:30 – LMX 242]
Long-Time Behavior of a PDE Replicator Equation for Multilevel Selection in Group-Structured Populations

In many biological systems, natural selection acts simultaneously on multiple levels of organization. This scenario typically presents an evolutionary conflict between the incentive of individuals to cheat and the collective incentive to establish cooperation within a group. Generalizing previous work on multilevel selection in evolutionary game theory, we consider a hyperbolic PDE model of a group-structured population, in which members within a single group compete with each other for individual-level replication ; while the group also competes against other groups for group-level replication. We derive a threshold level

of the relative strength of between-group competition such that defectors take over the population below the threshold while cooperation persists in the long-time population above the threshold. Under stronger assumptions on the initial distribution of group compositions, we further prove that the population converges to a steady state density supporting cooperation for between-group selection strength above the threshold. We further establish long-time bounds on the time-average of the collective payoff of the population, showing that the long-run population cannot outperform the payoff of a full-cooperator group even in the limit of infinitely-strong between-group competition. When the group replication rate is maximized by an intermediate level of within-group cooperation, individual-level selection casts a long shadow on the dynamics of multilevel selection: no level of between-group competition can erase the effects of the individual incentive to defect. We further extend our model to study the case of multiple types of groups, showing how the games that groups play can coevolve with the level of cooperation.

SONIA GAZEAU, University of Montreal

[Monday June 5 / lundi 5 juin, 9:00 – LMX 242]

Constructing virtual patient populations to understand immune responses in immunosuppressed and cancer patients with COVID-19

The COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has significantly affected the lives of billions of people, causing millions of deaths. It was recognized that particular groups of people, including the elderly, experienced more severe COVID-19. Additionally, patients with existing immunosuppression and those undergoing active cancer treatments are known to respond more poorly to the virus and the disease. However, clinical studies in those populations are difficult to perform, time and money consuming, and there is overall a lack clinical data to relate mechanisms of dysfunction to outcomes. Therefore, mathematical modelling, which enables studying complicated immune response mechanisms, can be a promising solution to the need for extensive longitudinal human data.

To study the immune dynamics after infection with SARS-CoV-2 in immunosuppressed and cancer patients, we adapted our existing mathematical model of the immune response in COVID-19. Using our established virtual patient cohort generation procedure, we used our model to generate virtual patient cohorts of cancer and immunosuppressed patients. Model predicts that both cancer and immunosuppressed virtual patients with severe COVID-19 have decreased CD8+ T cells and delayed IFN peaks. Additionally, our results show that cancer patients experience higher viral loads likely caused by decreased initial neutrophil counts (i.e. neutropenia), a frequent toxic side-effect of anti-cancer therapy. Together, our study suggests that immune dysregulation in COVID-19 is determined by dysfunction in IFN and CD8+ T cells, and that these may be considered as biomarkers of severity. Further, they represent potential treatment targets in susceptible patient groups.

QING HAN, York University

[Monday June 5 / lundi 5 juin, 15:30 – LMX 242]

Evaluation of the impact on pertussis transmission dynamics of adult and maternal boosting programs in the province of Ontario

Pertussis, a highly contagious infection of the respiratory tract, was one of the main causes of child morbidity and mortality in developed countries, in the pre-vaccine era. Following the scale-up and roll-out of childhood vaccination programs in the 1940s–1960s, the incidence and severity of pertussis decreased drastically. However, despite high vaccination coverage rates for more than 50 years, pertussis is now still a re-emerging disease and new vaccination strategies are in demand. Here, we developed a novel age-structured mathematical model which allows progressive waning of natural and vaccine-induced immunity, and distinguishes between clinical and sub-clinical infections. Imported cases and seasonal infections from out-of-province traveling were also considered. After fitted to and validated by the age-stratified pertussis incidence data, the model was used to produce simulations to evaluate maternal immunization and repeated adult boostings in the province of Ontario.

Mathematical Modelling of Ecological, Evolutionary and Infectious Disease Dynamics
Modélisation mathématique de la dynamique des maladies écologiques, évolutives et infectieuses

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JUDE KONG, York University
[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 242]
Mpox dynamic model: incorporating adaptive behavioural changes, control strategies in the MSM community & under-reporting.

Monkeypox, a zoonotic disease caused by the monkeypox virus, is emerging as a potential sexually transmitted disease (STD). Starting from the end of April 2022, a monkeypox outbreak is ongoing. Mathematical modelling plays a crucial role in monitoring, controlling, and forecasting infectious disease outbreaks, including those generated by STDs. In this talk, I will present a compartmentalized epidemiological model that we designed to track the dynamics of Monkeypox and the results we obtained from analyzing the model. The model incorporates sexual behaviour dynamics and stratified the population into high- and low-risk groups. We explore and compare different intervention strategies targeting the high-risk population: i) a scenario of control strategies, implementing a policy geared towards the use of condoms and/or sexual abstinence (robust control strategy) ; ii) a scenario of control strategies with risk compensation behaviour change, assuming a compensation through conducting more sexual encounters for adopting protective behavioural strategies (risk compensation strategy) ; and, iii) a scenario of control strategies with behaviour change in response to the doubling rate (adaptive control strategy).

MICHAEL LI, University of Alberta
[Monday June 5 / lundi 5 juin, 8:00 – LMX 242]
Nonidentifiability in Parameter Estimation of Simple and Complex Epidemic Models

Nonindentifiability in parameter estimation from data refers to the situation when multiple values of a set of parameters can produce the same best fit between the model and data (e.g. positive case reports of COVID-19), but different best-fit parameter values lead to significantly different predictions on un-observed quantities (e.g number hidden infections or total infections). A root cause of nonidentifiability in parameter estimation for diseases of viral infections (e.g. COVID-19, influenza, and HIV) is that the positive case report data only represents a fraction of all infections in a day (or week, year), and that fraction is also unknown and high variable during different phases of the epidemic. I will explain using examples of COVID-19 how nonidentiofiability occurs in a simple and a more complex model, and potentially how we can resolve it.

JUNLING MA, University of Victoria
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 242]
Estimating the Effect of Contact Tracing During the Early State of an Epidemic

Contact tracing is an important intervention measure to control infectious diseases. We present a new approach that tracks contacts in a randomly mixed population, which allow us to precisely model the contact tracing process. The model resulting from this new approach allows us to study the effect of contact tracing and isolation of diagnosed patients on the control reproduction number and number of infected individuals. However, we found that case counts alone during an early stage of an outbreak before susceptible population have been depleted is not sufficient to identify key contact tracing parameters such as coverage probability (the fraction of contacts successfully tracked) and testing rate. We need the reason that a patient is tested for diagnosis, i.e., whether they are quarantined and showing symptom, or voluntarily tested due to symptom, or contact tracing while showing symptom. We then apply our model to estimate the effect of contact tracing on the basic reproduction number and epidemic size in Ontario, Canada.

CHINWENDU MADUBUEZE, York University, Toronto
[Monday June 5 / lundi 5 juin, 9:30 – LMX 242]
Modelling transmission dynamics of Lassa fever transmission with environmental pathway transmission

Lassa Fever, caused by the Lassa virus, is an animal-borne disease endemic in some regions of Africa with a rodent called a natal multimammate rat as a natural reservior. It occurs more during the dry season when the bushes are dry and burned in

preparation for the farming season, making the rodents move into human habitats for food to survive. The rodents excrete their faeces and contaminate the environment making environmental transmission vital in Lassa fever transmission dynamics. Therefore, studying the contaminated environment's impact on Lassa fever is essential. This study used a deterministic model to examine the situation of Lassa fever transmission incorporating two environmental pathway transmissions. First, the model's stability is established regarding the model's basic reproduction number, R_0. Further, the model implements the sensitivity analysis to identify the parameters that fuel the Lassa fever spread using the Partial Rank Correlation Coefficient technique based on the Latin hypercube sampling.

TYLER MEADOWS, Queen's University
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 242]
Microbial Competition in a Serial Transfer Culture

Serial transfer culture is a common method used in microbiology to cultivate microorganisms. In this technique, a growth medium is inoculated with a small amount of microbes. After a fixed amount of time, a sample is taken from this medium and used to inoculate fresh growth medium. We expand on an existing impulsive differential equation model for microbial competition in this scenario. We establish conditions for when multiple species will coexist and conditions for when competitive exclusion holds.

ZAHRA MOVAHEDI NIA, York University
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 242]
Predicting Hotspots of Marburg Virus in Africa using Ecological Niche Modeling

Straw-coloured or Eidolon helvum bats are known as the reservoir of many re-emerging zoonotic diseases such as filoviruses, i.e. Ebola and Marburg virus. On March 22, 2023, a Marburg virus outbreak was reported in Equatorial Guinea. Marburg virus is a dangerous disease with up to 90

BLESSING OGBUOKIRI, York University
[Monday June 5 / lundi 5 juin, 17:00 – LMX 242]
Vaccine Hesitancy Hotspots in Africa: An Insight From Geotagged Twitter Posts

Many social media users express concerns about vaccines and their side effects on Twitter, leading to a compromise in confidence that results in vaccine hesitancy. In Africa, vaccine hesitancy poses a significant challenge for health policymakers in the battle against COVID-19. By leveraging the geotagging feature available in most tweets, it is possible to cluster them based on their sentiments, thereby facilitating the identification of locations that are more likely to experience vaccine hesitancy. This information can be valuable for health policy and planning purposes. In this study, we collected 70,000 geotagged vaccine-related tweets from nine African countries, spanning from December 2020 to February 2022. These tweets were categorized into three sentiment classes: positive, negative, and neutral. We employed various machine learning classifiers, namely Naïve Bayes, logistic regression, support vector machines, decision tree, and K-nearest neighbor, to achieve high-quality classification outputs. Among these classifiers, logistic regression demonstrated the highest accuracy, reaching 71

CARLY ROZINS, York University
[Sunday June 4 / dimanche 4 juin, 17:30 – LMX 242]
Why Are Bat-Borne Viruses So Deadly ?

The management of future pandemic risk requires a better understanding of the mechanisms that determine the virulence of emerging zoonotic viruses. Bats host viruses that cause higher case fatality rates upon spillover to humans than those derived from any other mammal. In order to disentangle the fundamental drivers of virulence upon spillover, we develop a nested modelling framework that highlights mechanisms which underpin the evolution of viral traits in reservoir hosts that cause

virulence following cross-species emergence. Our work offers a mechanistic explanation for the extreme virulence of bat-borne zoonoses and, more generally, demonstrates how key differences in reservoir host longevity, viral tolerance, and constitutive immunity impact the evolution of viral traits that cause virulence following spillover to humans.

YOGITA SHARMA, University of Victoria
[Monday June 5 / lundi 5 juin, 17:30 – LMX 242]
Effect of stochasticity and spatial structure on homing-based gene drive spread

Since the discovery and application of CRISPR as a gene editing tool, interest has grown in gene drive systems and their ability to spread desirable genes into populations. A variety of modeling approaches have been applied to study the spatial spread of gene drive systems, including partial differential equations, metapopulation models, and deterministic, stochastic and individual-based formulations. Here, we focus on reaction-diffusion approaches in which gene drive spread is described as a "pushed" or "pulled" wave. We compare a deterministic reaction-diffusion model of gene drive to one incorporating stochasticity, and explore the impact that stochasticity has on model outcomes. We find that, first, incorporating stochasticity into the model expands the range of fitness costs and initial conditions that lead to spatial spread. Second, increasing the level of stochasticity causes traveling wave solutions in the model to display decreased wave speed. And third, while a barrier representing a selective disadvantage to gene drive organisms may halt a traveling wave in a deterministic model formulation, in the stochastic model formulation, a small number of gene drive organisms may permeate the barrier and reestablish a traveling wave on the other side. These results highlight the limitations of deterministic reaction-diffusion models and the importance of considering stochasticity and spatial structure in models of gene drive spread as projects move towards field implementation.

ALISON SIMMONS, University of Toronto
[Monday June 5 / lundi 5 juin, 16:00 – LMX 242]
Pneumococcal Transmission Dynamics in Canada: 2010–2019

Streptococcus pneumoniae is a bacterium that causes a wide range of diseases, notably invasive pneumococcal disease, community acquired pneumonia, and acute otitis media. It primarily spreads through oral contact and respiratory secretions. Between 20% and 60% of healthy children and 10% of healthy adults in Canada are transiently colonized with *S. pneumoniae*. Currently, most children in Canada receive three or four doses of the 13-valent pneumococcal conjugate vaccine, which aims to protect vaccine recipients from severe disease caused by 13 serotypes of *S. pneumoniae*. Higher valency pneumococcal conjugate vaccines, which cover 15 and 20 serotypes of *S. pneumoniae*, are being considered for use in pediatric populations by advisory groups globally. In addition to preventing severe disease, the 13-valent pneumococcal conjugate vaccine prevents *S. pneumoniae* colonization. The herd effects necessitate the development of a dynamic transmission model to capture the transmission dynamics of *S. pneumoniae* to inform future vaccine recommendations. We developed an age-structured compartmental model that describes pneumococcal transmission dynamics in the Canadian population using a modified 'Susceptible-Infectious-Susceptible' framework. Our model contains additional compartments that incorporate *S. pneumoniae* serotype groupings and vaccination status. We fit our model to the annual incidence of invasive pneumococcal disease by serotype group between 2010 and 2019 in Canada using Latin hypercube sampling.

STACEY SMITH ?, The University of Ottawa
[Sunday June 4 / dimanche 4 juin, 17:00 – LMX 242]
Modelling mutation in equine infectious anemia virus infection suggests a path to viral clearance with repeated vaccination

Equine infectious anemia virus (EIAV) is a lentivirus similar to HIV that infects horses. Clinical and experimental studies demonstrating immune control of EIAV infection hold promise for efforts to produce an HIV vaccine. Antibody infusions have been shown to block both wild-type and mutant virus infection, but the mutant sometimes escapes. Using these data, we develop a mathematical model that describes the interactions between antibodies and both wild-type and mutant virus populations, in the context of continual virus mutation. The antibody infusions are modelled using impulsive differential equations, a technique that offers insight into repeated vaccination by approximating the time-to-peak by an instantaneous change. We use impulsive

theory to determine the maximal vaccination intervals that would be required to reduce the wild-type and mutant virus levels below one particle per horse. We show that seven boosts of the antibody vaccine are sufficient to eradicate both the wild-type and the mutant strains. In the case of a mutant virus infection that is given infusions of antibodies targeting wild-type virus (i.e., simulation of a heterologous infection), seven infusions were likewise sufficient to eradicate infection, based upon the data set. However, if the period between infusions was sufficiently increased, both the wild-type and mutant virus would eventually persist in the form of a periodic orbit. These results suggest a route forward to design antibody-based vaccine strategies to control viruses subject to mutant escape.

XIAOYING WANG, Trent University
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 242]
Studying the fear effect in a predator-prey system with apparent competition

Recent experimental evidence shows that the mere presence of predators may largely reduce the reproduction success of prey. The loss of prey's reproduction rate is attributed to the cost of anti-predator defense of prey when the prey perceives predation risks. We propose a predator-prey model where the prey shares a common enemy that leads to apparent competition between the prey and also the cost of anti-predator defense. Analytical results give the persistence conditions for the population densities of the prey and the predator. Numerical simulations demonstrate rich dynamics, such as the bi-stability of an equilibrium and a limit cycle. Results also reveal how the prey and the predator may coexist when the anti-predator defense level varies in prey. A relatively strong anti-predator defense in the prey may drive the population density of the prey to extinction and change the original coexistence of all the prey and the predator where the population densities oscillate periodically. Alternatively, strong anti-predator defense in the prey may facilitate the coexistence of the prey and the predator at a steady state.

WOLDEGEBRIEL ASSEFA WOLDEGERIMA, York University
[Monday June 5 / lundi 5 juin, 8:30 – LMX 242]
Modelling the impact of temperature change and rainfall on the spread of vector-borne diseases: malaria as a case study

Climate change may favourite the abundance of a population of vectors such as mosquitoes due to favourable breeding conditions and thus may lead to the spread of vector-borne diseases (VBDs). In this talk, I will present a climate-based non-autonomous malaria model with a periodic environment used to investigate the impact of climatic variables (majorly temperature and rainfall) on the spread of v. As such, the infection rate of humans by vectors and vectors by humans, and the death rate of vectors are temperature-dependent, meanwhile, the development rate of larvae to adult vectors is assumed to be both temperature and rainfall-dependent. I will briefly show some of the main mathematical properties and stability analysis of the non-autonomous system. The basic reproductive number, which is written as an integrator-differential depends on the duration of the transmission period and the date of the first infection case that was declared in the specific case of the VBD. Using average temperature and rainfall data, simulations are done to check the prevalence of infections in a region due to these seasonal factors. The findings show that malaria transmission in the area is seasonal, with an annual epidemic peak occurring between May and July. During these months, weather is conducive for the breeding of adult mosquitoes, the development of mosquito larvae and the successful transmission of the disease. A further investigation into the effect of larvae death, adult death, biting rate, and carrying capacity, is carried out relative to the reproduction number.

PEI YUAN, York University
[Monday June 5 / lundi 5 juin, 10:00 – LMX 242]
Will the vaccination strategies for monkeypox prevent outbreaks at gatherings ? —a case study in Canada

The outbreaks of monkeypox in non-endemic countries have led the World Health Organization to declare a Public Health Emergency of International Concern. Festivals, parties, and other gatherings may have contributed to the outbreak, particularly in the post-pandemic period. Public health has prepared vaccines in case of larger gatherings. In this talk, I will present a modelling study on how and if vaccination strategies combined with other public health measures can prevent or contribute to mitigating or halting outbreaks from mass gathering events. Working with public health agencies, we establish dynamic models

to mimic the spreading of the virus in human populations and distinguish the human population into higher and low-risk groups. I will present the public health measures essential to mitigate the spread and prevent potential future outbreaks at gatherings. This is joint work with the Public Health Agency of Canada and supported by CDM and OMNI-RÉUNIS, one health modelling network of Canada.

Mathematical modelling in public health
Modélisation mathématique en santé publique

Org: Hongbin Guo (University of Ottawa), **Felicia Magpantay** (Queen's University) and/et **Xiaoying Wang** (Trent University)

This session will bring together researchers working on mathematical epidemiology with expertise in the development, analysis and inference of disease models, to present their recent advances and mathematical challenges. This session will also serve as a platform for junior and senior researchers to exchange new ideas and initiate potential collaborations.

Cette session réunira des chercheurs travaillant sur l'épidémiologie mathématique et ayant une expertise dans le développement, l'analyse et l'inférence de modèles de maladies, afin de présenter leurs avancées récentes et leurs défis mathématiques. Cette session servira également de plateforme pour les chercheurs juniors et seniors pour échanger de nouvelles idées et initier des collaborations potentielles.

Schedule/Horaire — Room/Salle: LMX 242

Saturday June 3 — samedi 3 juin

9:00 - 9:30	Michael Li (University of Alberta), *An Epidemic Enigma: Challenges in Modeling the Influenza Epidemic in a Boarding School* (p. 123)
9:30 - 10:00	Ping Yan (Public Health Agency of Canada), *A proportional incidence rate model for aggregated data on vaccine effectiveness against COVID-19 hospital/ICU admissions* (p. 125)
10:00 - 10:30	Michael WZ Li (Public Health Agency of Canada), *The Past, Present and the Future of Mathematical Modeling Supporting Public Health* (p. 123)
15:00 - 15:30	Daihai He (Hongkong Ploytechnic University), *Resolving the enigma of Iquitos and Manaus: A modelling analysis of multiple COVID-19 epidemic waves in two Amazonian cities* (p. 122)
15:30 - 16:00	Xi Huo (University of Miami), *Vector-borne disease outbreak prevention: linking mosquito trap data to mathematical models* (p. 123)
16:00 - 16:30	Bryce Morsky (Florida State University), *The impact of threshold decision mechanisms of collective behaviour on disease spread* (p. 124)
16:30 - 17:00	Yijun Lou (Hongkong Ploytechnic University), *Getting jab or regular test: observations from an impulsive epidemic COVID-19 model* (p. 124)
17:00 - 17:30	Yanyu Xiao (University of Cincinnati), *Investigations the optimal de-escalation strategies during pandemic* (p. 125)

Sunday June 4 — dimanche 4 juin

9:00 - 9:30	Xiaoying Wang (Trent University), *Studying the mixed transmission in a community with age heterogeneity: COVID-19 as a case study* (p. 124)
9:30 - 10:00	Mingran Zhang (University of Victoria), *Modeling the Proliferation and Regulation of CD4+ T Cells During an Immune Response* (p. 125)
10:00 - 10:30	Sicheng Zhao (Queens University), *A Review of Bond Percolation Methods on Epidemic Network Models* (p. 125)

Abstracts/Résumés

DAIHAI HE, Hong Kong Polytechnic University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 242]
Resolving the enigma of Iquitos and Manaus: A modelling analysis of multiple COVID-19 epidemic waves in two Amazonian cities

Mathematical modelling in public health
Modélisation mathématique en santé publique

The nearby cities of Iquitos (Peru) and Manaus (Brazil) experienced the world's highest infection and mortality rates during the first COVID-19 wave in 2020. Key studies suggested that >70% of the city populations were infected in this wave and thus close to herd immunity and protected. It remains an enigma as to why a deadly second wave followed in Manaus worse than the first. To resolve this, we present a data-driven model of epidemic dynamics in Iquitos which we use to help explain and model events in Manaus. The partially observed Markov process model simultaneous fits a flexible "variable R0", estimates long-term immunity waning and impulsive immune evasion, and thus provides a comprehensive framework for characterizing and modeling new variants of concern.

XI HUO, University of Miami

[Saturday June 3 / samedi 3 juin, 15:30 – LMX 242]

Vector-borne disease outbreak prevention: linking mosquito trap data to mathematical models

Aedes aegypti is responsible for a few arbovirus transmissions. In this talk, I will present how we connect differential equation parameters with the mosquito trap data collected from 2017 to 2019. The model is then used to compare the Ae. aegypti population and evaluate the impact of rainfall intensity in different urban built environments. Our results show that rainfall affects the breeding sites and the abundance of Ae. aegypti more significantly in tourist areas than in residential places. In addition, we apply the model to quantitatively assess the effectiveness of vector control strategies in Miami-Dade County in South Florida, USA.

MICHAEL LI, University of Alberta

[Saturday June 3 / samedi 3 juin, 9:00 – LMX 242]

An Epidemic Enigma: Challenges in Modeling the Influenza Epidemic in a Boarding School

I will revisit a classical modeling example of an influenza epidemic in a boarding school in the UK, which was first described in the British Medical Journal (March 4, 1978). The application of an SIR model to describe the epidemic has appeared in well-known textbooks, as well as numerous lecture notes and presentations on the internet. It is shown that the number of infected $I(t)$ can fit the data very well, allowing estimation of the two model parameters and the basic reproduction number. What the modeling examples failed to check is that the final size, which is the total number or percentage of infected people during the epidemic, predicted by the calibrated models (close to 730 students or 96

MICHAEL WZ LI, Public Health Agency of Canada

[Saturday June 3 / samedi 3 juin, 10:00 – LMX 242]

The Past, Present and the Future of Mathematical Modeling Supporting Public Health

Mathematical modeling has been critical in supporting public health initiatives, providing valuable insights into disease dynamics, intervention strategies, and resource allocation. This talk explores the past, present, and future of mathematical modeling in supporting public health, highlighting its transformative impact on addressing complex health challenges in different eras.

In the past, mathematical modeling laid the foundations for understanding basic disease transmission dynamics. For example, R0 provides insights into the potential for disease transmission and helps inform public health interventions; the SIR (Susceptible-Infectious-Recovered) model, allowed researchers to simulate and predict the spread of infectious diseases, aiding in the formulation of effective public health interventions.

In the present era, math modeling has become an indispensable tool in public health research and practice. Advancements in computational power, data availability, and demands for supporting public health policies, practices, and surveillance led to more sophisticated models, incorporating real-world data and parameters. Collaborative efforts with multidisciplinary have opened up many possibilities to advance the state-of-the-art modeling supporting public health.

Looking toward the future, math modeling holds immense promise in transforming public health practices. Advanced modeling techniques provide a more nuanced understanding of disease dynamics, biological mechanisms, and social interactions. Integration of evolving real-time data sources such as genomics, serological, sentinel, and citizen science surveillance enhances

modeling. Lastly, to fully leverage the potential of math modeling, interdisciplinary collaborations, and stakeholder engagement are crucial. By involving public health experts, policymakers, scientists, and communities in the modeling process, models can be co-developed to address public health challenges.

YIJUN LOU, The Hong Kong Polytechnic University
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 242]
Getting jab or regular test: observations from an impulsive epidemic COVID-19 model

Several safe and effective vaccines are available to prevent people from getting seriously ill or dying from the coronavirus disease 2019 (COVID-19) and widespread vaccination is believed to be a critical tool to fight the disease. However, individuals with vaccine hesitancy or other medical conditions may choose not to vaccinate, and regular compulsory testing is required in some sectors for such unvaccinated individuals. It is interesting to find that different sectors pose various testing frequencies, for example on a weekly or biweekly basis, and it becomes an important scientific problem to determine the test frequency and identify underlying factors. This talk is going to present a population based model to accommodate different personal decision choices (getting vaccination or regular tests), vaccine efficacies and uncertainties in the epidemic transmission. The model, in the form of impulsive differential equations, uses time instant to represent the reporting date for the test result of an unvaccinated individual. By employing some well-acceptable indices to measure the transmission risk, including the basic reproduction number, the peaking time and the final size, an optimal test frequency is shown to be very sensitive to parameters involved in the transmission process, including vaccine efficacy, disease transmission rate, the test accuracy, and the existing vaccination coverage. The testing frequency should be appropriately designed with the consideration of all these factors, as well as the control objectives measured by epidemiological quantities of great concern.

BRYCE MORSKY, Florida State University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 242]
The impact of threshold decision mechanisms of collective behaviour on disease spread

Humans are a hyper social species, which greatly impacts the spread of infectious diseases. How do social dynamics impact epidemiology ? How does public health policy best take into account these impacts ? Here we develop a model of disease transmission that incorporates human behaviour and social dynamics. We use a "tipping-point" dynamic, previously used in the sociological literature, where individuals adopt a behaviour given a sufficient frequency of the behaviour in the population. The thresholds at which individuals adopt behaviours is modulated by the perceived risks of infection, i.e. the disease prevalence and transmission rate, and the behaviour of others. Social conformity creates a type of "stickiness" whereby individuals are resistant to changing their behaviour due to the population's inertia. In this model, the epidemic attack rate is sensitive to the timing of the behavioural response. Near the optimal response, small errors can result in large increases in the total number infected during the epidemic. And, more surprisingly, we observe a non-monotinicity in the attack rate as a function of various biological and social parameters such as the transmission rate, efficacy of social distancing, the costs to social distancing, the weight of social consequences of shirking the norm, and the degree of heterogeneity in the population.

XIAOYING WANG, Trent University
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 242]
Studying the mixed transmission in a community with age heterogeneity: COVID-19 as a case study

COVID-19 has been prevalent worldwide for about 2 years now and has brought unprecedented challenges to our society. Before vaccines were available, the main disease intervention strategies were non-pharmaceutical. Starting December 2020, in Ontario, Canada, vaccines were approved for administering to vulnerable individuals and gradually expanded to all individuals above the age of 12. As the vaccine coverage reached a satisfactory level among the eligible population, normal social activities resumed and schools reopened starting September 2021. However, when schools reopen for in-person learning, children under the age of 12 are unvaccinated and are at higher risks of contracting the virus. We propose an age-stratified model based on the age and vaccine eligibility of the individuals. We fit our model to the data in Ontario, Canada and obtain a good fitting result.

The results show that a relaxed between-group contact rate may trigger future epidemic waves more easily than an increased within-group contact rate. An increasing mixed contact rate of the older group quickly amplifies the daily incidence numbers for both groups whereas an increasing mixed contact rate of the younger group mainly leads to future waves in the younger group alone. The results indicate the importance of accelerating vaccine rollout for younger individuals in mitigating disease spread.

YANYU XIAO, University of Cincinnati
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 242]
Investigations the optimal de-escalation strategies during pandemic

n this work, we examined some optimal paths for contact relaxing strategies during the de-escalation phase of a pandemic.

PING YAN, Public Health Agency of Canada
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 242]
A proportional incidence rate model for aggregated data on vaccine effectiveness against COVID-19 hospital/ICU admissions

We develop a proportional incidence model that estimates vaccine effectiveness (VE) at the population level using conditional likelihood for aggregated data. Our model assumes that the population counts of clinical outcomes for an infectious disease arise from a superposition of Poisson processes with different vaccination statuses. The intensity function in this model is calculated as the product of per capita incidence rate and the at-risk population size, both of which are time-dependent. We then formulate a log-linear regression model with respect to the relative risk, defined as the ratio between the per capita incidence rates of vaccinated and unvaccinated individuals. In the regression analysis, we treat the baseline incidence rate as a nuisance parameter, like the Cox proportional hazard model in survival analysis. We apply the proposed models and methods to age-stratified weekly counts of COVID-19-related hospital and ICU admissions among adults in Ontario, Canada. The data, spanning from 2021 to February 2022, encompass the Omicron era and the rollout of booster vaccine doses. We also discuss the limitations and confounding effects while advocating for the necessity of more comprehensive and timely individual-level data that document the clinical outcomes and measure potential confounders.

MINGRAN ZHANG
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 242]
Modeling the Proliferation and Regulation of CD4+ T Cells During an Immune Response

Most mathematical models for immune responses incorporating CD4+ T cell dynamics, such as HIV models, overly simplify this proliferation as an exponential growth with a rate less than the death rate of CD4+ T cells. Yet the autocrine reaction of IL-2 and CD4+ T cells suggests a much faster response, and the clearance of activated CD4+ T cells after the infection depends on induced regulatory T cells (Tregs). We prove mathematically that the interaction of IL-2, CD4+ T cells, and Tregs allows two modes of proliferation: the first mode is solely driven by the activation of naive CD4+ T cells, and the second mode is an excitable response in which the Treg population rapidly but briefly increases to a high level. These two modes are characterized by whether the proliferation rate is dominated by the CD4+ T cell death rate. We extend our model to include more realistic regulation terms and fit the models to CD4+ count data. The best-fit model parameters show that the immune system operates in the excitable mode.

SICHENG ZHAO, Queen's University
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 242]
A Review of Bond Percolation Methods on Epidemic Network Models

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), Bansal &

Meyers (2012) and Miller, Slim & Volz (2011). 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.

Mathematics of Machine Learning
Mathématiques de l'apprentissage automatique

Org: Ben Adcock (Simon Fraser University), **Tanya Schmah** (University of Ottawa), **Giang Tran** (University of Waterloo) and/et **Hamid Usefi** (Memorial University)

Gaps between theory and practice in machine learning raise the pressing need for a broader, more comprehensive mathematical foundations. This session is the fourth in a series, and will be a forum for discussing and exploring emerging ideas in this fast-growing and exciting field. 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, and optimization methods for machine learning.

Les écarts entre la théorie et la pratique de l'apprentissage automatique soulèvent le besoin pressant d'une base mathématique plus large et plus complète. Cette session est la quatrième d'une série, et sera un forum pour discuter et explorer les idées émergentes dans ce domaine passionnant et en pleine croissance. Les sujets abordés comprennent (sans s'y limiter) : l'apprentissage profond, l'explicabilité et l'interprétabilité des réseaux neuronaux profonds, le traitement du langage naturel, la sélection des traits et la réduction de la dimensionnalité, la classification et la régression, et les méthodes d'optimisation pour l'apprentissage automatique.

Schedule/Horaire **Room/Salle: LMX 451**

Saturday June 3 **samedi 3 juin**

8:30 - 9:00	Vincent Létourneau (University of Ottawa), *Complexity measures and regret bounds in reinforcement learning from classical statistical learning theory* (p. 129)
9:00 - 9:30	Tiffany Vlaar (Mila), *Constrained and Multirate Training of Neural Networks* (p. 130)
9:30 - 10:00	Haizhao Yang (University of Maryland), *Finite Expression Method: A Symbolic Approach for Scientific Machine Learning* (p. 130)
10:00 - 10:30	Kimon Fountoulakis (University of Waterloo), *Graph Attention Retrospective* (p. 128)
15:00 - 15:30	Jason Bramburger (Concordia University), *Auxiliary functions as Koopman observables* (p. 128)
15:30 - 16:00	Vakhtang Putkaradze (University of Alberta), *Lie-Poisson Neural Networks* (p. 129)
16:00 - 16:30	Aaron Berk (McGill University), *Variational properties of square root LASSO: Smoothness, uniqueness, explicit solutions* (p. 127)
16:30 - 17:00	Anastasis Kratsios (McMaster University), *A Transfer Principle: Universal Approximators Between Metric Spaces From Euclidean Universal Approximators* (p. 128)
17:00 - 17:30	Martina Neuman (Michigan State University), *Superiority of GNN over NN in generalizing bandlimited functions* (p. 129)

Abstracts/Résumés

AARON BERK, McGill University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 451]
Variational properties of square root LASSO: Smoothness, uniqueness, explicit solutions

The square root LASSO (SR-LASSO) is a powerful sparse regularization technique widely adopted in statistics, and increasingly popular in the scientific computing and machine learning communities. SR-LASSO is the sum of a data fidelity term and a one-norm weighted by a tuning parameter. It closely resembles the unconstrained formulation of LASSO (Least Absolute Shrinkage and Selection Operator), essentially obtained by "removing" the square from the latter's data fidelity term. This algebraic transformation corresponds with optimal tuning strategies for SR-LASSO that are robust to unknown observation errors. Our goal is to study the (generally, set-valued) solution map of SR-LASSO to determine its sensitivity to the measurement vector and tuning parameter. We present how three increasingly strict assumptions give rise to correspondingly "nice" properties of the

SR-LASSO solution map. Our investigation is based on variational analysis, continuing a line of work initiated by the current authors for unconstrained LASSO. First, we show the weakest assumption yields uniqueness for SR-LASSO solutions. The intermediate assumption additionally yields directional differentiability (hence Lipschitzness) of the solution map, as well as an analytic expression for the solution. The final assumption yields continuous differentiability (with respect to the measurement vector and tuning parameter). When the solution is Lipschitz we obtain informative explicit bounds on the Lipschitz constant and contrast this quantification of sensitivity with that for unconstrained LASSO. Compelling numerics flesh out the theoretical discussion.

JASON BRAMBURGER, Concordia University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 451]
Auxiliary functions as Koopman observables

Many important statements about dynamical systems can be proved by finding scalar-valued auxiliary functions whose time evolution along trajectories obeys certain pointwise inequalities that imply the desired result. The most familiar of these auxiliary functions is a Lyapunov function to prove steady-state stability, but such functions can also be used to bound averages of ergodic systems, define trapping boundaries, and so much more. In this talk I will highlight a method of identifying auxiliary functions from data using polynomial optimization. The method leverages recent advances in approximating the Koopman operator from data, so-called extended dynamic mode decomposition, to provide system-level information without system identification. The result is a model-agnostic computational method that can be used to bound quantities of interest, develop optimal state-dependent feedback controllers, and discover invariant measures.

KIMON FOUNTOULAKIS, Cheriton School of Computer Science, University of Waterloo
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 451]
Graph Attention Retrospective

Graph-based learning is a rapidly growing sub-field of machine learning with applications in social networks and bioinformatics. One of the most popular models is graph attention networks. They were introduced to allow a node to aggregate features of neighbour nodes in a non-uniform way, in contrast to simple graph convolution which does not distinguish the neighbours of a node. In this presentation I will discuss multiple results on the performance of graph attention for the problem of node classification for a contextual stochastic block model. The node features are obtained from a mixture of Gaussians and the edges from a stochastic block model. I will show that in an "easy" regime, where the distance between the means of the Gaussians is large enough, graph attention is able to distinguish inter-class from intra-class edges. Thus it maintains the weights of important edges and significantly reduces the weights of unimportant edges. Consequently, I will show that this implies perfect node classification. In the "hard" regime, I will show that every attention mechanism fails to distinguish intra-class from inter-class edges. In addition, I will show that graph attention convolution cannot (almost) perfectly classify the nodes even if intra-class edges could be separated from inter-class edges. Beyond perfect node classification, I will discuss a positive result on graph attention's robustness against structural noise in the graph. In particular, the robustness result implies that graph attention can be strictly better than both the simple graph convolution and the best linear classifier of node features.

ANASTASIS KRATSIOS, McMaster
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 451]
A Transfer Principle: Universal Approximators Between Metric Spaces From Euclidean Universal Approximators

We build universal approximators of continuous maps between arbitrary Polish metric spaces X and Y using universal approximators between Euclidean spaces as building blocks. Earlier results assume that the output space Y is a topological vector space. We overcome this limitation by "randomization": our approximators output discrete probability measures over Y. When X and Y are Polish without additional structure, we prove very general qualitative guarantees ; when they have suitable combinatorial structure, we prove quantitative guarantees for Hölder-like maps, including maps between finite graphs, solution operators to rough differential equations between certain Carnot groups, and continuous non-linear operators between Banach spaces arising

in inverse problems. In particular, we show that the required number of Dirac measures is determined by the combinatorial structure of X and Y. For barycentric Y, including Banach spaces, R-trees, Hadamard manifolds, or Wasserstein spaces on Polish metric spaces, our approximators reduce to Y-valued functions. When the Euclidean approximators are neural networks, our constructions generalize transformer networks, providing a new probabilistic viewpoint of geometric deep learning.

Joint work with: Chong Liu, Matti Lassas, Maarten V. de Hoop, and Ivan Dokmanić

Available at: ArXiV 2304.12231

VINCENT LÉTOURNEAU, University of Ottawa

[Saturday June 3 / samedi 3 juin, 8:30 – LMX 451]

Complexity measures and regret bounds in reinforcement learning from classical statistical learning theory

I will present recent work that makes use of classical statistical learning theory, specifically complexity measures of supervised learning, to probe the complexity of reinforcement learning problems. We consider a family $\mathcal{M}$ of MDPs over given state and action spaces, and an agent that is sequentially confronted with tasks from $\mathcal{M}$. Although stated for this stepwise change in distributions, the insight we develop is informative for continually changing distributions as well. In order to study how structure of $\mathcal{M}$, viewed as a learning environment, impacts the learning efficiency of the agent, we formulate an RL analog of fat shattering dimension for MDP families and show that this implies a nontrivial lower bound on regret as long as insufficiently many steps have been taken. More precisely, for some constant c which depends on shattering d states, an inexperienced agent that has explored the learning environment for fewer than d steps will necessarily have regret above c on some MDP in the family.

MARTINA NEUMAN, CMSE-MSU

[Saturday June 3 / samedi 3 juin, 17:00 – LMX 451]

Superiority of GNN over NN in generalizing bandlimited functions

Graph Neural Network (GNN) with its ability to integrate graph information has been widely used for data analyses. However, the expressive power of GNN has only been studied for graph-level tasks but not for node-level tasks, such as node classification, where one tries to interpolate missing nodal labels from the observed ones. In this paper, we study the expressive power of GNN for the said classification task, which is in essence a function interpolation problem. Explicitly, we derive the number of weights and layers needed for a GNN to interpolate a band-limited function in $\mathbb{R}^d$. Our result shows that, the number of weights needed to ϵ-approximate a bandlimited function using the GNN architecture is much fewer than the best known one using a fully connected neural network (NN) - in particular, one only needs $O((\log \epsilon^{-1})^d)$ weights using a GNN trained by $O((\log \epsilon^{-1})^d)$ samples to ϵ-approximate a discretized bandlimited signal in $\mathbb{R}^d$. The result is obtained by drawing a connection between the GNN structure and the classical sampling theorems, making our work the first attempt in this direction.

VAKHTANG PUTKARADZE, University of Alberta

[Saturday June 3 / samedi 3 juin, 15:30 – LMX 451]

Lie-Poisson Neural Networks

Physics-Informed Neural Networks (PINNs) have acquired a lot of attention in recent years due to their potential for high-performance computations for complex physical systems. The idea of PINNs is to approximate the equations, as well as boundary and initial conditions, through a loss function for a neural network. For applications to canonical Hamiltonian systems, structure-preserving Symplectic Neural Networks (SympNets) were developed, computing canonical transformations and further extended to non-canonical systems due to the application of Darboux's theorem by writing non-canonical systems locally in canonical coordinates. We extend this theory further by developing the Lie-Poisson neural networks (LPNets), which can approximate the motion of solutions on a Poisson manifold given the Poisson bracket. Our method is based on the approximation of the motion using analytically solved motion for test Hamiltonians and given Poisson bracket. The method preserves all Casimirs to machine precision and yields an efficient and promising computational method for the dynamics of several finite-dimensional Lie groups,

such as SO(3) (rigid body or satellite), SE(3) (Kirchhoff's equations for underwater vehicle) and other finite-dimensional Lie groups. We also discuss the applications of these ideas to infinite-dimensional systems.

Joint work with Chris Eldred (Sandia National Lab), Francois Gay-Balmaz (CNRS and ENS, France), and Sophia Huraka (U Alberta). The work was partially supported by an NSERC Discovery grant.

TIFFANY VLAAR, McGill University / Mila
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 451]
Constrained and Multirate Training of Neural Networks

I will describe algorithms for regularizing and training deep neural networks. Soft constraints, which add a penalty term to the loss, are typically used as a form ofexplicit regularization for neural network training. In this talk I describe a method for efficiently incorporating constraints into a stochast ic gradient Langevin framework for the training of deep neural networks. In contrast to soft constraints, our constraints offer direct control of the parameter space, which allows us to study their effect on generalization. In the second part of the talk, I illustrate the presence of latent multiple time scales in deep learning applications. Different features present in the data can be learned by training a neural network on different time scales simultaneously. By choosing appropriate partitionings of the network parameters into fast and slow parts I show that our multirate techniques can be used to train deep neural networks for transfer learning applications in vision and natural language processing in half the time, without reducing the generalization performance of the model.

HAIZHAO YANG, University of Maryland College Park
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 451]
Finite Expression Method: A Symbolic Approach for Scientific Machine Learning

Machine learning has revolutionized computational science and engineering with impressive breakthroughs, e.g., making the efficient solution of high-dimensional computational tasks feasible and advancing domain knowledge via scientific data mining. This leads to an emerging field called scientific machine learning. In this talk, we introduce a new method for a symbolic approach to solving scientific machine learning problems. This method seeks interpretable learning outcomes in the space of functions with finitely many analytic expressions and, hence, this methodology is named the finite expression method (FEX). It is proved in approximation theory that FEX can avoid the curse of dimensionality in discovering high-dimensional complex systems. As a proof of concept, a deep reinforcement learning method is proposed to implement FEX for learning the solution of high-dimensional PDEs and learning the governing equations of raw data.

Matrices and Operators (Bilingual Session)
Matrices et opérateurs (session bilingue)

Org: Ludovick Bouthat (Université Laval), **Javad Mashreghi** (Université Laval) and/et **Frédéric Morneau-Guérin** (TÉLUQ/Laval)

The objective of this session is to bring together researchers sharing an interest in various aspects of matrix theory or operator theory and to offer them the opportunity to discuss recent developments in these sub-disciplines.

L'objectif de cette session est de réunir des chercheurs partageant un intérêt pour divers aspects de la théorie des matrices ou de la théorie des opérateurs et de leur offrir l'opportunité de discuter des développements récents dans ces sous-disciplines.

Schedule/Horaire **Room/Salle: CRXC 408**

Saturday June 3 **samedi 3 juin**

8:30 - 9:00	William Verreault (Université Laval), *Nonlinear expansions in reproducing kernel Hilbert spaces* (p. 133)
9:00 - 9:30	Pierre-Olivier Parisé (University of Hawai at Manoa), *Divergence of Taylor Series in de Branges-Rovnyak Spaces* (p. 132)
9:30 - 10:00	Ludovick Bouthat (Université Laval), *Weighted averages of ℓ^p sequences: New generalizations of Hardy's inequality* (p. 131)
10:00 - 10:30	Rajesh Pereira (University of Guelph), *Linear maps which preserve convex sets and their geometric and spectral properties* (p. 132)
15:00 - 15:30	Frédéric Morneau-Guérin (TÉLUQ), *Poids de convolution sur ℓ^2* (p. 132)
15:30 - 16:00	Mathias Neufang (Carleton University), *Non-commutative Fejer theorems, and Arens regularity of the projective tensor product of C*-algebras* (p. 132)
16:00 - 16:30	Marcu-Antone Orsoni (University of Toronto) (p. 132)
16:30 - 17:00	Javad Mashreghi (Université Laval), *Carleson measures in classical function spaces* (p. 131)

Abstracts/Résumés

LUDOVICK BOUTHAT, Université Laval
[Saturday June 3 / samedi 3 juin, 9:30 – CRXC 408]
Weighted averages of ℓ^p sequences: New generalizations of Hardy's inequality

The classical Hardy inequality states that $\sum_{n=1}^{\infty}\left(\frac{a_1+\cdots+a_n}{n}\right)^p \leq \left(\frac{p}{p-1}\right)^p \sum_{n=1}^{\infty} a_n^p$, where $(a_n)_{n\geq 1}$ is a given sequence of nonnegative real number. The objective of this talk is to present three new Hardy-type inequalities in which the arithmetic mean over a sequence of nonnegative real numbers is replaced by some weighted arithmetic mean over some nested subsets of the given sequence of numbers. One of these inequalities stems from a calculation in a recent paper on semi-infinite matrices of Bouthat and Mashreghi.

JAVAD MASHREGHI, Laval University
[Saturday June 3 / samedi 3 juin, 16:30 – CRXC 408]
Carleson measures in classical function spaces

We study some "one-box condition" for Carleson measures in Hardy, Bergman and Dirichlet spaces. In particular, we show that a finite measure μ on the unit disk is a Carleson measure for the Dirichlet space if it satisfies the Carleson one-box condition $\mu(S(I)) = O(\phi(|I|))$, where $\phi : (0, 2\pi) \to (0, \infty)$ is an increasing function such that $\int_0^{2\pi} \phi(x)/x\, dx < \infty$. We also show that the integral condition on ϕ is sharp.

Joint work with O. El-Fallah, K. Kellay, T. Ransford.

FRÉDÉRIC MORNEAU-GUÉRIN, Universite TELUQ
[Saturday June 3 / samedi 3 juin, 15:00 – CRXC 408]
Poids de convolution sur ℓ^2

Il est bien connu que l'espace L^p pondéré sur un groupe localement compact est stable par rapport à la convolution si la fonction de pondération satisfait une certaine inégalité de convolution. Il existe plusieurs contre-exemples montrant que cette condition suffisante n'est pas nécessaire. Cependant, pour une classe de groupes, à savoir les groupes abéliens discrets, aucun contre-exemple n'est connu. Il subsiste donc une possibilité que l'inégalité de convolution caractérise vraiment la stabilité de la convolution pour les espaces L^p pondérés sur ces groupes. Dans cet exposé, nous étudions d'une part cette inégalité et, dans le cas $p = 2$, nous la réinterprétons à la lumière de la théorie des opérateurs et dans le contexte de la théorie des espaces de Hilbert à noyau reproductible. D'autre part, nous esquisserons quelques tentatives infructueuses de générer des contre-exemples.

MATHIAS NEUFANG, Carleton University and University of Lille
[Saturday June 3 / samedi 3 juin, 15:30 – CRXC 408]
Non-commutative Fejer theorems, and Arens regularity of the projective tensor product of C-algebras*

We present solutions to several problems concerning crossed products and tensor products of operator algebras. The common theme is our use of completely bounded module maps.

We prove that a locally compact group G has the approximation property (AP) if and only if a non-commutative Fejer theorem holds for the associated C^*- or von Neumann crossed products. We deduce that the AP always implies exactness. This generalizes a result of Haagerup-Kraus, and answers a question by Li. We also answer a problem of Bedos-Conti on discrete C^*-dynamical systems, and one by Anoussis-Katavolos-Todorov on bimodules over the group von Neumann algebra $VN(G)$ for all locally compact groups G with the AP. We also obtain a version of our von Neumann algebraic Fejer theorem for discrete quantum groups. (Joint work with J. Crann and S. Kazemi.)

It has been open for about 40 years to characterize when the projective Banach space tensor product $A \otimes_\gamma B$ of two C^*-algebras A and B is Arens regular. We solve this problem for arbitrary C^*-algebras: Arens regularity is equivalent to A or B having the Phillips property ; hence, it is encoded in the geometry of the algebras. For von Neumann algebras A and B, we conclude that $A \otimes_\gamma B$ is Arens regular only if A or B is finite-dimensional. This does not generalize to non-selfadjoint operator algebras. For a commutative C^*-algebra A, we prove that the centre of $(A \otimes_\gamma A)^{**}$ is Banach algebra isomorphic to the extended Haagerup tensor product $A^{**} \otimes_{eh} A^{**}$.

MARCU-ANTONE ORSONI, University of Toronto
[Saturday June 3 / samedi 3 juin, 16:00 – CRXC 408]

PIERRE-OLIVIER PARISÉ, University of Hawaii at Manoa
[Saturday June 3 / samedi 3 juin, 9:00 – CRXC 408]
Divergence of Taylor Series in de Branges-Rovnyak Spaces

In this talk, I will present sufficient conditions for the existence of a function in a given de Branges-Rovnyak space for which the Taylor series is unbounded in norm or diverges to infinity in norm. The result is a consequence of a refined version of the boundedness principle established by Müller and Vrsovsky. This is a joint work with Thomas Ransford.

RAJESH PEREIRA, University of Guelph
[Saturday June 3 / samedi 3 juin, 10:00 – CRXC 408]
Linear maps which preserve convex sets and their geometric and spectral properties

Matrices and Operators (Bilingual Session)
Matrices et opérateurs (session bilingue)

Let C be a convex subset of a vector space V and let $\{x_i\}$ be a finite collection of points in C. We consider the set of all linear maps from $V \to V$ that preserve both C and all of the points $\{x_i\}$. Specific choices of C and $\{x_i\}$ give the set of correlation matrices, the set of doubly stochastic matrices and the set of positive linear maps. We explore some geometric properties of these convex sets and some spectral properties of matrices in these convex sets.

WILLIAM VERREAULT, Université Laval
[Saturday June 3 / samedi 3 juin, 8:30 – CRXC 408]
Nonlinear expansions in reproducing kernel Hilbert spaces

I will introduce an expansion scheme in reproducing kernel Hilbert spaces, which as a special case covers the celebrated Blaschke unwinding series expansion for analytic functions, also known as adaptive Fourier decomposition. The expansion scheme can also be generalized to cover certain reproducing kernel Banach spaces. I will discuss convergence results for this series expansion, which has been a major question with the Blaschke unwinding, as well as a few concrete applications and examples.

This is based on joint work with Javad Mashreghi.

Noncommutative Algebra and Noncommutative Geometry
Algèbre et géométrie non commutative

Org: Jason Bell (University of Waterloo) and/et **Colin Ingalls** (Carleton University)

Noncommutative geometry is a discipline with strong connections to mathematical physics, representation theory, and algebraic geometry. The field is defined by its use of geometric methods in the study of difficult questions about noncommutative algebras. This session will bring together people working on many different aspects of noncommutative algebra and noncommutative geometry with a focus on recent work in quantum groups, Artin-Schelter regular algebras, and Brauer theory.

La géométrie non commutative est une discipline fortement liée à la physique mathématique, à la théorie des représentations et à la géométrie algébrique. Ce domaine est défini par l'utilisation de méthodes géométriques dans l'étude de questions difficiles sur les algèbres non commutatives. Cette session réunira des personnes travaillant sur de nombreux aspects différents de l'algèbre non commutative et de la géométrie non commutative, en mettant l'accent sur les travaux récents concernant les groupes quantiques, les algèbres régulières d'Artin-Schelter et la théorie de Brauer.

Schedule/Horaire — Room/Salle: LMX 218

Saturday June 3 — samedi 3 juin

8:30 - 8:55	Ellen Kirkman (Wake Forest University), *Homological Regularities* (p. 135)
9:00 - 9:25	Hongdi Huang (Rice University), *Weighted Poisson projective planes* (p. 135)
9:30 - 9:55	Xingting Wang (Howard University), *Poisson Valuation* (p. 136)
10:00 - 10:25	Matthew Satriano (University of Waterloo), *Noncommutative surfaces and stacky surfaces* (p. 135)
15:00 - 15:25	Emily Cliff (Université de Sherbrooke), *Twisted sheaves and quasi-universal bundles* (p. 134)
15:30 - 15:55	James Zhang (University of Washington), *Pivotal Automorphisms* (p. 136)
16:00 - 16:25	Kelly McKinnie (University of Montana) (p. 135)
16:30 - 16:55	Rajesh Kulkarni (Michigan State University) (p. 135)

Sunday June 4 — dimanche 4 juin

9:00 - 9:25	Kent Vashaw (MIT), *On the decomposition of tensor products of monomial modules for finite 2-groups* (p. 136)
9:30 - 9:55	Charles Paquette (Royal Military College of Canada), *Semi-invariant rings and complete intersections* (p. 135)
10:00 - 10:25	Padmini Veerapen (Tennessee Tech University), *Cocycle twists and Manin's universal quantum groups* (p. 136)

Abstracts/Résumés

EMILE BOUAZIZ, Carleton University
[LMX 218]

EMILY CLIFF, Université de Sherbrooke
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 218]
Twisted sheaves and quasi-universal bundles

This is based on joint work with Colin Ingalls and Charles Paquette. For a quiver $Q = (Q_0, Q_1)$ and dimension vector $d = (d_i)_{i \in Q_0}$ we study a coarse moduli M space of quiver representations. Let d be the greatest common divisor of the numbers d_i. In the case that $d = 1$, it is known that M admits a universal family U of representations, and hence is a fine

moduli space: that is, U is a sheaf of kQ-modules on M such that for every point $m \in M$ corresponding to a kQ-module V_m, the fibre U_m of U at m is isomorphic to the representation V_m. However, this fails when $d > 1$ (Reineke–Schröer, Hoskins–Schaffhauser); instead M admits a *quasi-universal* family $\tilde{U}$ whose fibre $\tilde{U}_m$ is isomorphic to a direct sum of copies of the representation V_m. In this talk, we will introduce the notion of twisted sheaves and sketch the construction of the sheaf $\tilde{U}$.

HONGDI HUANG, Rice University
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 218]
Weighted Poisson projective planes

In this talk, we will discuss graded unimodular Poisson structures on a weighted polynomial algebra $A = \Bbbk[x, y, z]$ defined by weighted homogeneous potentials Ω of degree being the sum of weights on x, y, z. These graded Poisson algebras correspond to weighted Poisson projective planes. Using Poisson valuations, we characterize the Poisson automorphism groups for A and $A/(\Omega - \xi)$ when the irreducible Ω has an isolated singularity and $\xi \in \Bbbk$. Besides, we will talk about the (co)homological invariant of these unimodular Poisson algebras determined by irreducible potentials.

ELLEN KIRKMAN, Wake Forest University
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 218]
Homological Regularities

Let A be a noetherian connected graded $\Bbbk$-algebra with a balanced dualizing complex, and let X be a cochain complex of graded left A-modules. The elements of X possess both an internal and various homological degrees, and it is useful to study the relationships between these degrees. Jørgensen and Dong-Wu extended the study of Tor-regularity and Castelnuovo-Mumford regularity from commutative algebras to noncommutative algebras. We consider these regularities further, and define new numerical invariants that involve linear combinations of internal and homological degrees. This is joint work with Robert Won and James J. Zhang.

RAJESH KULKARNI, Michigan State University
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 218]

KELLY MCKINNIE, University of Montana
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 218]

CHARLES PAQUETTE, Royal Military College of Canada
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 218]
Semi-invariant rings and complete intersections

Rings of semi-invariants of quivers (with relations) capture a lot of the geometry of the module varieties over finite dimensional algebras. They can be used to construct moduli spaces of representations, and their weight spaces can give us information on the representation type of the algebra. Not much is known about the structure of these rings, in general. In this talk, we will analyse the cases where we have an irreducible component with orbits of small co-dimension and show that under some conditions, we get that these semi-invariant rings are complete intersections. This is joint work with Deepanshu Prasad and David Wehlau.

MATTHEW SATRIANO, University of Waterloo
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 218]
Noncommutative surfaces and stacky surfaces

Noncommutative Algebra and Noncommutative Geometry
Algèbre et géométrie non commutative

Understanding the extent to which noncommutative objects are determined by commutative ones is an important theme in noncommutative geometry, and is an underlying principle of the noncommutative McKay correspondence. We prove that there is a dictionary between noncommutative surfaces and smooth stacky surfaces which gives equivalences on the level of derived categories. This is joint work with Eleonore Faber, Colin Ingalls, and Shinnosuke Okawa.

KENT VASHAW, Massachusetts Institute of Technology
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 218]
On the decomposition of tensor products of monomial modules for finite 2-groups

Dave Benson conjectured recently that a tensor power $V^{\otimes n}$ of an odd-dimensional indecomposable representation for a finite 2-group G has a unique odd-dimensional indecomposable summand, and that the function sending n to the dimension of this summand is quasi-polynomial. We explore the analogous conjecture for graded representations of a related finite group scheme, and give some of first nontrivial verifications of this conjecture. This project is joint with George Cao.

PADMINI VEERAPEN, Tennessee Tech University
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 218]
Cocycle twists and Manin's universal quantum groups

We examine 2-cocycle twists of a family of infinite-dimensional Hopf algebras, known as Manin's universal quantum groups, denoted by $\underline{\mathrm{aut}}(A)$, which Manin showed, universally coact on connected graded quadratic algebras, A. In this talk, we consider $\underline{\mathrm{aut}}(A)$ under a more general setting, namely, when A is a finitely generated algebra subject to m-homogeneous relations and show how $\underline{\mathrm{aut}}(A)$ can be twisted by 2-cocycles. This is joint work with V. C. Nguyen, H. Huang, C. Ure, K. B. Vashaw, and X. Wang.

XINGTING WANG, Howard University
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 218]
Poisson Valuation

We will talk about Poisson valuation and its application in computing Poisson automorphism groups of Poisson elliptic algebras. It is joint work with Hongdi Huang, Xin Tang and James Zhang.

JAMES ZHANG, University of Washington
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 218]
Pivotal Automorphisms

Pivotal automorphisms of an algebra will be introduced and be calculated for the polynomial algebras by using valuations of n-Lie Poisson algebras. Joint work with Hongdi Huang, Xin Tang, and Xingting Wang.

Noncommutative Geometry and Mathematical Physics
Géométrie non commutative et physique mathématique

Org: Masoud Khalkhali (Western University) and/et **Raphael Ponge** (Sichuan/Ottawa)

Noncommutative geometry (in the sense of Alain Connes) has applications in various fields of mathematics and mathematical physics. We aim at bringing together junior and senior researchers from various backgrounds to present recent progress in this area. This will be the opportunity for junior mathematicians in this field to present their work and interact with senior experts.

Schedule/Horaire **Room/Salle: LMX 254**

Saturday June 3 **samedi 3 juin**

9:00 - 9:30	Nathan Pagliaroli (Western University, Canada), *Liouville Quantum gravity from Noncommutative Geometry* (p. 139)
9:30 - 10:00	Luuk Verhoeven (Western University, Canada), *Fermionic fuzzy geometries* (p. 141)
10:00 - 10:30	Sitanshu Gakkhar (Caltech, USA), *A quantum stochastic approach to spectral action* (p. 138)
15:00 - 15:30	Heath Emerson (U. Victoria, Canada), *Heisenberg spectral cycles for flows* (p. 137)
15:30 - 16:00	Edward McDonald (Penn State U, USA), *The Dixmier trace and the Density of States* (p. 139)
16:00 - 16:30	Ahmad Reza Haj Saeedi Sadegh (Northeastern U, USA), *Deformation Spaces and localized equivariant index formulas for groupoids* (p. 139)
16:30 - 17:00	Yiannis Loizides (George Mason U, USA), *A fixed-point formula for Dirac operators on Lie groupoids* (p. 139)
17:00 - 17:30	Ilya Shapiro (U Windsor, Canada), *Hopf-cyclic coefficients for a Hopf algebra in a rigid braided category.* (p. 140)

Sunday June 4 **dimanche 4 juin**

9:30 - 10:00	Therese Landry (UC Santa Barbara, USA), *Spectral Triples for Noncommutative Solenoids* (p. 138)
10:00 - 10:30	Damien Tageddine (McGill U., Canada), *Noncommutative geometry on discrete spaces* (p. 140)
15:00 - 15:30	Venkata Karthik Timmavajjula (University of New Brunswick, Canada), *Extended diffeomorphism groups for noncommutative manifolds* (p. 140)
15:30 - 16:00	Michael Francis (Western University, London, ON, Canada), *Homological unitality of smooth groupoid algebras* (p. 138)
16:00 - 16:30	Jesus Sanchez Jr. (Washington U. in St Louis, USA), *The Spectral Zeta Cocycle* (p. 140)
16:30 - 17:00	Daniel Hudson (University of Toronto, Canada), *Weightings for Lie Groupoids and Lie Algebroids* (p. 138)

Abstracts/Résumés

HEATH EMERSON, University of Victoria
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 254]
Heisenberg spectral cycles for flows

The annihilation and creation operators x+d/dx, x-d/dx, assemble to an even spectral triple over the crossed product of the C*-algebra A of bounded uniformly continuous functions on the real line, by the real line as a discrete topological group. Taking a single orbit of a smooth (ergodic) flow on a compact manifold determines, by restricting functions to the orbit, a C*-subalgebra of A and, taking into account the spectral triple, one gets an example of a 'Noncommutative Geometry' in the sense of A. Connes, associated to the flow. I will discuss application of the Local Index Formula to this situation, with especial attention to the analytic zeta function associated to the spectral triple. The meromorphic extension problem and pole structure

of this zeta function turns out to be related to certain delicate points in the study of ergodic time averages. Krönecker flow on the 2-torus already illustrates this in an interesting way, as we will briefly explain.

MICHAEL FRANCIS, University of Western Ontario
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 254]
Homological unitality of smooth groupoid algebras

For any Lie group G, the smooth convolution algebra $C_c^\infty(G)$ is nonunital (unless G is discrete), but a celebrated result of Dixmier-Malliavin says the following weaker property holds:

$$\text{Every } \varphi \in C_c^\infty(G) \text{ is a finite sum } \sum f_i * g_i \text{ where } f_i, g_i \in C_c^\infty(G).$$

In a recent article, I extended this result to the case where G is a Lie groupoid. Writing $A = C_c^\infty(G)$, this says exactly that the map $A \otimes A \to A$ defined by convolution product is surjective. Continuing this work, I show that A is homologically unital in the sense of Wodzicki, meaning the bar complex

$$\cdots \longrightarrow A^{\otimes 4} \longrightarrow A^{\otimes 3} \longrightarrow A^{\otimes 2} \longrightarrow A \longrightarrow 0$$

is exact. Wodzikci showed homological unitality is precisely the property needed by an ideal to perform excision in cyclic/Hochschild homology, i.e. the condition for a short exact sequence of algebras to induce a long exact sequence.

For a Lie groupoid G with base X, the concept of an invariant submanifold $Y \subseteq X$ is meaningful (this is consistent with the usual meaning in the group action case). In terms of the smooth convolution algebra, invariant submanifolds manifest as ideals $I_Y^k \subseteq C_c^\infty(G)$, where k encodes an order of vanishing along Y. I furthermore show that I_Y^k is homologically unital for $k = \infty$, which means excision holds for infinite-order vanishing ideals associated to invariant submanifolds. This result gives an organizing principle for calculating cyclic/Hochschild homology: localize the calculation around invariant submanifolds.

SITANSHU GAKKHAR, California Institute of Technology
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 254]
A quantum stochastic approach to spectral action

We review the spectral action for Robertson-Walker cosmologies and consider an approach through quantum stochastic processes. Towards this, we study the heat semigroups for almost commutative spectral triples characterized as endomorphim subalgebras of spinor bundles, and show that they are quantum dynamical semigroups. Then using the Goswami-Sinha quantum stochastic calculus, the existence of Evans-Hudson flows which can be viewed as defining diffusion processes on the spectral triple is established.

PIOTR M. HAJAC, IMPAN, Poland
[LMX 254]

DANIEL HUDSON, University of Toronto
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 254]
Weightings for Lie Groupoids and Lie Algebroids

Weightings, or quasi-homogeneous structures, are a concept introduced by Melrose and later by Loizides and Meinrenken as a way to generalize the notion of order of vanishing. Loizides and Meinreken show that, given a weighting, one can define a 'weighted normal bundle' and a 'weighted deformation space' in a way that generalizes the standard normal bundle and standard deformation to the normal cone. In this talk, we will discuss the appropriate notions of weightings in the case of Lie algebroids and Lie groupoids so as to ensure that a number of desirable properties hold.

THERESE LANDRY, University of California, Santa Barbara
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 254]
Spectral Triples for Noncommutative Solenoids

We construct odd finitely summable spectral triples based on length functions of bounded doubling on noncommutative solenoids. Our spectral triples induce a Leibniz Lip– norm on the state spaces of the noncommutative solenoids, giving them the structure of Leibniz quantum compact metric spaces. By applying methods of R. Floricel and A. Ghorbanpour, we also show that our odd spectral triples on noncommutative solenoids can be considered as direct limits of spectral triples on rotation algebras.

YIANNIS LOIZIDES, George Mason University
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 254]
A fixed-point formula for Dirac operators on Lie groupoids

I will describe an equivariant index formula for a family of Dirac operators on the source fibres of a Lie groupoid. The result complements work of Heitsch-Lazarov and Pflaum-Posthuma-Tang. This is joint work with Liu, Sadegh and Sanchez. This will be one part of a two-part talk, the other part being the talk of A.R.H.S. Sadegh.

EDWARD MCDONALD, Penn State University
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 254]
The Dixmier trace and the Density of States

The Dixmier trace has been employed by Connes for several purposes, including defining the integral in noncommutative geometry. Connes' integration formula can be viewed as a way of associating a measure to a self-adjoint operator. In solid state physics there is another celebrated measure associated with Schrodinger operators: the density of states. Using techniques from noncommutative geometry, we have recently proved that the density of states can in many cases be computed by a Dixmier trace. This work also provides a new perspective on Roe's index theorem for open manifolds by giving a Dixmier trace formula for the index. Joint work with N. Azamov, E. Hekkelman, F. Sukochev and D. Zanin.

NATHAN PAGLIAROLI, Western University
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 254]
Liouville Quantum gravity from Noncommutative Geometry

In this talk we will highlight recent developments in toy models of Quantum Gravity originating from Noncommutative Geometry. The models of interest are finite real spectral triples equipped with a path integral over the space of possible Dirac operators, dubbed Dirac ensembles. In the noncommutative geometric setting of spectral triples, Dirac operators take the center stage as a replacement for a metric on a manifold. Thus, this path integral serves as a noncommutative analogue of integration over metrics, a key feature of a theory of quantum gravity.

Such models can be shown to be bi-tracial random matrix integrals. Using well-established rigorous techniques of Random Matrix Theory, we derive the critical exponents and the asymptotic expansion of partition functions of various Dirac ensembles which match that of minimal models from Liouville conformal field theory coupled with gravity.

AHMAD REZA HAJ SAEEDI SADEGH, Northeastern University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 254]
Deformation Spaces and localized equivariant index formulas for groupoids

This talk is based on joint work with Liu, Sanchez, and Loizides. In this talk, we discuss the application of deformation spaces in

studying localized equivariant index formulas for groupoids. This work generalizes the results of Higson-Yi and Braverman-Haj. This is part of a two-part talk, the other delivered by Yiannis Loizides.

JESUS SANCHEZ JR., Washington University in St Louis
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 254]
The Spectral Zeta Cocycle

In this talk we use D. Quillen's Chern-Weil theory for cyclic cohomology to calculate the transgression relations for the spectral zeta cocycle introduced by N. Higson in relation to the Connes-Moscovici noncommutative local index theorem. We use the transgression relations to give an explicit homotopy to the Connes-Chern character.

ILYA SHAPIRO, University of Windsor
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 254]
Hopf-cyclic coefficients for a Hopf algebra in a rigid braided category.

A classical anti-Yetter-Drinfeld module for a Hopf algebra H was defined by Hajac-Khalkhali-Rangipour-Sommerhauser as a module and a comodule over H such that the two structures are compatible in a specific sense. These objects serve as necessary coefficients for cyclic cohomology theories of H-equivariant algebras.

If $\mathcal{B}$ is a braided category then there is a notion of a Hopf algebra H in $\mathcal{B}$. A braided version of anti-Yetter-Drinfeld modules has been considered by Khalkhali-Pourkia, and more recently by Bartulovic. These approaches generalize the classical definition, and are successful to the point of 1-dimensional coefficients (modular pairs in involution) for a balanced braided $\mathcal{B}$.

On the other hand, the classical definition has been variously generalized, and in particular, it is now possible to talk about anti-Yetter-Drinfeld modules for a monoidal category. Note that H-modules in $\mathcal{B}$ form a monoidal category $\mathcal{C}$. We will describe anti-Yetter-Drinfeld modules for $\mathcal{C}$ as modules and comodules (compatibly) over H, but not, as one would guess, in $\mathcal{B}$. Instead, one needs to replace $\mathcal{B}$ with anti-Yetter-Drinfeld modules for $\mathcal{B}$. This leads to an interesting decomposition result for the category of coefficients. The 1-dimensional coefficients for a balanced braided $\mathcal{B}$, mentioned above, form a part of this decomposition, when they exist.

DAMIEN TAGEDDINE, McGill University
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 254]
Noncommutative geometry on discrete spaces

The approximation theory of partial differential equations on smooth manifolds can take several aspects. The various methods rely on the intuitive geometric idea that the fine structure of space is discrete. The resulting discretized space is governed by a small parameter $\hbar$ which plays the role of infinitesimal.

A natural question is to determine a general framework, i.e. a unifying treatment of continuous and discrete geometries. Noncommutative differential geometry, and more specifically the construction of spectral triples, offers a promising direction to formalize approximation theory of differential operator using the same tool as classical differential geometry.

In this talk, we will start by reviewing how to associate a spectral triple to a triangulation of a given smooth manifold. Then, we will show how a sequence of spectral triples, associated to a sequence of refined triangulations, can be related at the limit $\hbar \to 0$ to the spectral triple on a spin manifold. In fact, we observe a convergence in average when the Dirac operators are taken as random matrices with a suitable distribution on the coefficients.

VENKATA KARTHIK TIMMAVAJJULA, University of New Brunswick, Fredericton
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 254]
Extended diffeomorphism groups for noncommutative manifolds

Given an unital pre-C^* algebra B with a $*$-exterior algebra, one can define extended diffeomorphism group for the noncommutative manifold B and its subgroup of topologically trivial elements. Using results of Bratteli–Elliott–Jorgensen and Krähmer, we compute these groups when B is an irrational noncommutative 2-torus and the algebraic standard Podleś sphere, respectively. We then apply this to the computation of moduli spaces of solutions to Euclidean Maxwell's equations with fixed topological sector and current 1-form.

This is joint work with B. Ćaćić.

LUUK VERHOEVEN, UWO

[Saturday June 3 / samedi 3 juin, 9:30 – LMX 254]

Fermionic fuzzy geometries

A random fuzzy geometry consists of a fuzzy geometry, i.e. a spectral triple $(M_N(\mathbb{C}), V \otimes M_N(\mathbb{C}), D)$ where the Dirac operator is a random variable with some predetermined distribution of the form $\frac{1}{Z}e^{-S(D)}dD$, traditionally these actions $S(D)$ consist of traces of powers of D. In this talk I will discuss some of the difficulties associated to adding a fermionic term to this action as well as some new results on the effect of such a fermionic term for a fuzzy geometry of signature $(0,1)$.

This is joint work with Nathan Pagliaroli and Masoud Khalkhali.

Numerical Methods for Partial Differential Equations
Méthodes numériques pour les équations différentielles partielles

Org: Yves Bourgault and/et **Diane Guignard** (University of Ottawa)

This session will cover recent developments in the field of numerical methods for solving partial differential equations, including such topics as error estimation, adaptive algorithms, geometrical methods, and uncertainty quantification.equations, for instance error estimation, adaptive algorithms, geometrical methods, uncertainty quantification, etc.

Cette session couvrira les développements récents dans le domaine des méthodes numériques pour la résolution des équations aux dérivées partielles, y compris des sujets tels que l'estimation des erreurs, les algorithmes adaptatifs, les méthodes géométriques et la quantification des incertitudes.

Schedule/Horaire **Room/Salle: LMX 418**

Saturday June 3 **samedi 3 juin**

8:00 - 8:30	André Fortin (Université Laval), *A discontinuous Galerkin method for stiff ODEs and DDEs* (p. 144)
8:30 - 9:00	Sander Rhebergen (University of Waterloo), *Space-time HDG for the advection-diffusion equation on time-dependent domains in the limit of small diffusion* (p. 145)
9:00 - 9:30	Baptiste Berlioux (Polytechnique Montréal), *A-stable and high order nonlinear time integration methods based on deferred correction schemes* (p. 143)
9:30 - 10:00	Seth Taylor (McGill University), *A characteristic mapping method for incompressible hydrodynamics on a rotating sphere* (p. 146)
10:00 - 10:30	Francis Aznaran (Oxford), *Transformations for Piola-mapped elements* (p. 142)
15:00 - 15:30	Luis Mora (University of Waterloo), *On the Strictly Uniform Exponential Decay of a Mixed-FEM Discretization for the Wave Equation with Boundary Dissipation* (p. 144)
15:30 - 16:00	Jean Deteix (Université Laval), *A projection scheme for the Navier–Stokes/Allan–Cahn model* (p. 143)
16:00 - 16:30	Paride Passeli (École Polytechnique Fédérale de Lausanne, Switzerland), *Anisotropic Adaptive Finite Elements for a p-Laplace Like Problem. An Application to Aluminium Electrolysis* (p. 145)
16:30 - 17:00	Qiwei Feng (University of Alberta), *High Order Finite Difference Methods for Interface Problems* (p. 143)
17:00 - 17:30	Maude Girardin (École Polytechnique Fédérale de Lausanne, Switzerland), *Error Assessment for a Finite Element - Neural Network Approach Applied to Parametric PDEs* (p. 144)
17:30 - 18:00	Emmanuel Lorin (Carleton University), *Neural network-based discontinuity tracking for hyperbolic conservation laws* (p. 144)

Abstracts/Résumés

FRANCIS AZNARAN, University of Oxford
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 418]
Transformations for Piola-mapped elements

Many finite element spaces are not preserved by the standard pullback to the reference cell. Robust implementation therefore requires studying the relation between degrees of freedom under pushforward, in order to obtain the correct bases on a generic physical triangle [Kirby, 2018]. In this work, we extend this transformation theory to vector- and tensor-valued elements mapped by the contravariant Piola transform. We apply this theory, and describe its efficient implementation in Firedrake, for the the Mardal–Tai–Winther elements discretising $H(\mathrm{div})$ for Stokes–Darcy flow, and the conforming and nonconforming Arnold–Winther elements discretising $H(\mathrm{div};\mathbb{S})$ for the stress-displacement formulation of linear elasticity.

In particular, the Arnold–Winther elements were the first to stably enforce exact symmetry of the Cauchy stress tensor ; we demonstrate how they may be efficiently mapped, while the few prior implementations are either custom-made for specific

numerical experiments, or require the explicit element-by-element construction of the basis. Our novel implementation of these exotic elements composes inexpensively and automatically with the rest of the Firedrake code stack. We also demonstrate the effectiveness of appropriate multigrid smoothers for this system, prove convergence of Nitsche's method for the weak enforcement of traction conditions, and provide a uniform construction of all standard reference-to-physical Piola pullback maps using the finite element exterior calculus.

BAPTISTE BERLIOUX, Polytechnique Montréal
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 418]
A-stable and high order nonlinear time integration methods based on deferred correction schemes

The starting point of our methods is the A-stable BDF (Backward Differentiation Formulae) schemes of order 1 and 2. Our methods consist in gradually increasing the order of these schemes from deferred corrections, while keeping the unconditional stability. The dominant terms of the local truncation error are substituted from the initial expression of the BDF1 and BDF2 methods. The substituted term is then the correction, interpolated by a Newton polynomial from the solution of the lower order method, supposed to be the most accurate. For example, the DC2/BDF1 method substitutes the term $-\ddot{u}(t^n)\frac{k_n}{2!}$ (first dominant term of the truncation error of the BDF1 scheme) in the expression of the BDF1 scheme. Concerning $\ddot{u}(t^n)$, it is interpolated from the numerical solution u_1^n, resulting from the BDF1 solution at time t^n, in order to make it discrete. By construction of the correction, the DC2/BDF1 method is then of order 2.

By applying the same strategy, we gradually increase the order of the methods and can expect to reach very high orders (DC6/BDF, DC7/BDF, etc.).

But, because of the interdependence of the methods, the restriction of the order allows limiting the complexity of implementation as well as the computational cost. Thus, in order to limit this one, we aim to build an algorithm with adaptive time steps in order to minimize the number of time steps. Before that, it is necessary to verify the numerical behaviour of the methods in different time step configurations.

JEAN DETEIX, Université Laval
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 418]
A projection scheme for the Navier–Stokes/Allan–Cahn model

Projection methods are known for their efficicency for Newtonian fluids. However their use in the context of variable density or viscosity is problematic (but not impossible). We propose in this work a time-discrete formulation of the coupled Navier–Stokes/Allen–Cahn equations based on a projection method. The scheme is based on two ingredients: a projection method for heterogeneous fluid and the concept of coupled projection scheme.

We first establish the well posedness and stability of the time-discrete formulation. Next we propose an iterative schemes for the actual approximation of solutions.In the last part of our presentation, using finite element for spatial discretization, we estimate the order of accuracy in time and illustrate the validity of the scheme through numerical results.

QIWEI FENG, University of Alberta
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 418]
High Order Finite Difference Methods for Interface Problems

Interface problem arises in many applications such as modeling of underground waste disposal, oil reservoir, composite material, and many others. The coefficient a, the source term f, the wave number k, the solution u, and the flux $a\nabla u \cdot \vec{n}$ are possibly discontinuous across the interface curve Γ in such problems. To obtain the reasonable numerical solution, the higher order numerical scheme is desirable. Firstly, we propose a sixth order compact 9-point finite difference method (FDM) for the Poisson interface problem with the singular source. For the elliptic interface problem with the discontinuous and piecewise smooth coefficient, we propose a high order compact 9-point FDM and a high order local calculation for the approximation of the solution u and the gradient ∇u respectively. Furthermore, we derive the compact 9-point FDM with high accuracy

order and/or M-matrix property for the elliptic cross-interface problem. Finally, we propose a sixth order compact FDM for the Helmholtz Equation with the singular source. To reduce the pollution effect, we propose a new pollution minimization strategy that is based on the average truncation error of plane waves. All above schemes are developed on the uniform Cartesian grid in a rectangular domain. Our numerical experiments confirm the flexibility and the expected order accuracy in l_2 and l_∞ norms of the proposed schemes. Except the Helmholtz Equation, we prove the corresponding convergence rate for the proposed schemes using the discrete maximum principle. This is joint work with Bin Han, Peter Minev and Michelle Michelle.

ANDRÉ FORTIN, Université Laval
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 418]
A discontinuous Galerkin method for stiff ODEs and DDEs

We present a very high order implicit discontinuous Galerkin method for the solution of stiff ordinary differential equations (ODEs) and delay differential equations (DDEs). The proposed method is based on Legendre orthogonal polynomials of degree k and is shown to converge at order $k+1$ in L^2 and sup norms. We show how the error can be estimated allowing a very efficient control of the time step. We also propose a breaking point detection algorithm for DDEs. We will present numerous examples (with $k=10$ and thus converging at order 11) to illustrate the efficiency of the method: stiff ODES with discontinuous right-hand sides, stiff DDEs with discontinuous solutions (breaking points), neutral DDEs, DDEs where classical solutions cease to exist, etc.

MAUDE GIRARDIN, EPFL
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 418]
Error Assessment for a Finite Element - Neural Network Approach Applied to Parametric PDEs

A parametric PDE

$$\mathcal{F}(u(x;\mu);\mu) = 0 \quad x \in \Omega, \quad \mu \in \mathcal{P}, \tag{1}$$

where Ω denotes the physical domain and $\mathcal{P}$ the parameters domain, is considered. Depending on the differential operator $\mathcal{F}$, numerical methods used to approximate the solution of (1) may be time consuming, which is an issue in the many query context (e.g. if an inverse problem has to be solved) or if the solution is needed in real time. To overcome this issue, we aim to build a neural network that approximates the map $(x;\mu) \mapsto u(x;\mu)$. For this purpose, we compute numerical approximations $u_h(x;\mu_i)$ of $u(x;\mu_i)$, $i = 1, \dots, M$, and use them as a train set for the neural network. We are then interested in the error between u and the approximation given by the network, that we denote by $u_\mathcal{N}$. More precisely, we want to estimate $||u - u_\mathcal{N}||_{L^2(\Omega\times\mathcal{P})}$, which can be split as

$$||u - u_\mathcal{N}||_{L^2(\Omega\times\mathcal{P})} \leq ||u - u_h||_{L^2(\Omega\times\mathcal{P})} + ||u_h - u_\mathcal{N}||_{L^2(\Omega\times\mathcal{P})}.$$

In the presentation, we discuss how the two error terms can be estimated, to what extend we can ensure that they are balanced and we present numerical results for a model problem. If time permits, we will also discuss how the neural network can be used to solve an inverse problem.

EMMANUEL LORIN
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 418]
Neural network-based discontinuity tracking for hyperbolic conservation laws

We develop neural network-based algorithms for accurately solving weak solutions to hyperbolic conservation laws. The principle is to compute the solution in space-time subdomains defined by the curves of discontinuity, constructed from the Rankine-Hugoniot jump conditions. The proposed approach allows to efficiently consider an arbitrary number of entropic shock waves, shock wave generation, as well as wave interactions. Some numerical experiments are presented to illustrate the strengths of the algorithms.

Numerical Methods for Partial Differential Equations
Méthodes numériques pour les équations différentielles partielles

LUIS MORA, University of Waterloo

[Saturday June 3 / samedi 3 juin, 15:00 – LMX 418]

On the Strictly Uniform Exponential Decay of a Mixed-FEM Discretization for the Wave Equation with Boundary Dissipation

Many approximation methods, such as standard finite elements, fail to preserve the decay rate of dissipative wave problems. Strictly preservation of the exponential stability by a first-order mixed finite element approximation method is shown for the one-dimensional wave equation with a partially reflective boundary. We use the multiplier method to analyze the continuous system's exponential stability, expressing the exponential decay rate and amplitude as functions of the physical parameters and boundary dissipation gain. An equivalent analysis is applied to prove that the energy of the approximated model is exponentially stable, and also to provide a similar bound in terms of the physical parameters.

PARIDE PASSELI, Ecole Polytechnique Fédérale de Lausanne

[Saturday June 3 / samedi 3 juin, 16:00 – LMX 418]

Anisotropic Adaptive Finite Elements for a p-Laplace Like Problem. An Application to Aluminium Electrolysis

Simulating Aluminium Electrolysis is a complex multi-scale and multi-physics task. Here we are interested in the fluid-flow problem describing the movements of liquid aluminium and electrolytic bath. In order to find a trade off between computational time and accuracy, Adaptive Finite Elements with large aspect ratio are considered. As a test case the p-Laplacian like problem $-\nabla \cdot ((\mu + |\nabla u|^{p-2})\nabla u) = f$, when $\mu \geq 0$ and $p \geq 2$ is considered. Using the anisotropic setting of [1, 2] and the quasi-norm techniques in [3], an anisotropic a posteriori error estimate is proved. A mesh adaptive strategy is presented. Numerical experiments show the sharpness of the estimator on both fixed and adapted meshes. Finally the developed strategy is applied to Aluminium Electrolysis.

References

[1] L. Formaggia, and S. Perotto. New anisotropic a priori error estimates. Numer. Math., Vol. 89(4), pp. 641-667, 2001.

[2] L. Formaggia, and S. Perotto. Anisotropic error estimates for elliptic problems. Numer. Math., Vol. 94(1), pp. 67-92, 2003.

[3] W. Liu, and N. Yan. Quasi-norm local error estimators for p-laplacian. SIAM J. NUMER. ANAL., Vol. 30(1), pp. 100-127, 2001.

SANDER RHEBERGEN, University of Waterloo

[Saturday June 3 / samedi 3 juin, 8:30 – LMX 418]

Space-time HDG for the advection-diffusion equation on time-dependent domains in the limit of small diffusion

This work is in collaboration with Yuan Wang. The time-dependent advection-diffusion equation on a time-dependent domain $D(t) \subset R^d$ is given by:

$$\partial_t \theta + \mathbf{u} \cdot \nabla \theta - \nu \nabla^2 \theta = f, \qquad \mathbf{x} \in D(t),\ t \in (0, T]. \qquad (1)$$

Here θ is the quantity of interest, $\mathbf{u}$ is a flow field, and $\nu > 0$ a diffusion parameter.

The space-time framework facilitates the discretization of PDEs on moving domains: a time-dependent PDE is re-formulated as a "stationary" PDE in $(d+1)$ space-time which is then discretized by a finite element method.

In [1] we introduced the space-time hybridizable discontinuous Galerkin method for (1). In [2] we analyzed this discretization assuming a sufficiently large diffusion parameter ν. In this talk I will present a new analysis of the space-time HDG method focusing on the small diffusion limit ($\nu \ll 1$).

[1] S. Rhebergen and B. Cockburn, Space-time hybridizable discontinuous Galerkin method for the advection-diffusion equation on moving and deforming meshes, in The Courant-Friedrichs-Lewy (CFL) condition, 80 years after its discovery, ed. C.A. de Moura and C.S. Kubrusly, pp. 45-63 (2013).

[2] K.L.A. Kirk, T. Horvath, A. Cesmelioglu and S. Rhebergen, Analysis of a space-time hybridizable discontinuous Galerkin method for the advection-diffusion problem on time-dependent domains, SIAM J. Numer. Anal., 57, 4, pp. 1677-1696 (2019).

SETH TAYLOR, McGill University

[Saturday June 3 / samedi 3 juin, 9:30 – LMX 418]

A characteristic mapping method for incompressible hydrodynamics on a rotating sphere

We present a semi-Lagrangian method for diffeomorphism approximation and its application to incompressible hydrodynamics on the sphere. The method approximates the flow of a velocity field using a spatio-temporal discretization formed by a composition of submaps. This technique substitutes the effects of spatial refinement with the operation of composition by adaptively growing the temporal discretization. In turn, the method has the capacity of accurately and sparsely representing the generation of fine scales globally using only a linear increase in the degrees of freedom. The design and analysis of the method is presented and supported through numerical experimentation on some canonical geophysical flows.

Optimal Transport in Natural and Data Sciences
La théorie du transport dans les sciences naturelles et informatiques

Org: Augusto Gerolin (University of Ottawa) and/et **Abbas Momeni** (Carleton University)

This session unites researchers from complementary mathematical and scientific communities who have been or are keen on working on optimal transport and its applications. Topics include but are not limited to: theory, computations, optimal transport as learning methodology, and applications to physics, natural sciences and statistics. All researchers are warmly encouraged to submit an abstract for consideration.

Cette session réunit des chercheurs des communautés mathématiques et scientifiques complémentaires qui ont travaillé ou souhaitent travailler sur la théorie du transport et ses applications. Les sujets comprennent, sans s'y limiter, la théorie, les calculs, la théorie du transport en tant que méthodologie d'apprentissage, et les applications à la physique, aux sciences naturelles et aux statistiques. Tous les chercheurs sont chaleureusement encouragés à soumettre un résumé pour considération.

Schedule/Horaire **Room/Salle: LMX 390**

Saturday June 3 **samedi 3 juin**

8:00 - 8:30	Brendan Pass (Alberta) (p. 149)
9:00 - 9:30	Mohammad Ali Ahmadpoor Jadehkenary (Carleton), *Uniqueness of optimal plans for multi-marginal mass transport problems via a reduction argument* (p. 148)
9:30 - 10:00	Adolfo-Vargas Jimenez (Ottawa), *Dispersion Interactions in the Strictly Correlated Electron Limit of DFT via Multi-Marginal Optimal Transp* (p. 148)
10:00 - 10:30	Nataliia Monina (Ottawa), *Multimarginal Optimal Transport with Neural Networks* (p. 149)
15:00 - 15:30	Annina Lieberherr (University of Oxford), *Optimal Transport distances for classifying electronic excitations* (p. 149)
15:30 - 16:00	Fanch Coudreuse (École normale supérieure de Lyon), *Quantum Optimal Transport and applications to Quantum Gaussian states* (p. 147)
16:30 - 17:00	Dmitry Evdokimov (Ottawa), *Computational aspects of Optimal Transport: classical and quantum* (p. 148)
17:00 - 17:30	Robert de Keijzer (Eindhoven University of Technology), *Pulse based Variational Quantum Optimal Control for hybrid quantum computing* (p. 147)

Abstracts/Résumés

FANCH COUDREUSE, ENS de Lyon
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 390]
Quantum Optimal Transport and applications to Quantum Gaussian states

Optimal Transport has proven to be a powerful tool in a wide range of mathematical subjects, and its application to the non-commutative and Quantum setting has attracted significant interest in recent years. In this seminar, we will provide a comprehensive introduction to the different formulations of Quantum Optimal Transport, from basic transport to regularized optimal transport. We will discuss the advantages and limitations of each formulation. In particular, we will focus on the transport of Gaussian states, which are commonly used in quantum information theory and quantum optics. Through this example, we will explore the key concepts and techniques involved in Quantum Optimal Transport, and discuss open research questions and future directions in the field.

ROBERT DE KEIJZER, Eindhoven University of Technology
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 390]
Pulse based Variational Quantum Optimal Control for hybrid quantum computing

In this talk we discuss pulse based variational quantum algorithms (VQAs), which are designed to determine the ground state of a quantum mechanical system by combining classical and quantum hardware. In contrast to more standard gate based methods, pulse based methods aim to directly optimize the laser pulses interacting with the qubits, instead of using some parametrized gate based circuit. Using the mathematical formalism of optimal control, these laser pulses are optimized. This method has been used in quantum computing to optimize pulses for quantum gate implementations, but has only recently been proposed for full optimization in VQAs. Pulse based methods have several advantages over gate based methods such as faster state preparation, simpler implementation and more freedom in moving through the state space.

Based on these ideas, we present the development of a novel adjoint based variational method. This method can be tailored towards and applied in neutral atom quantum computers. This method of pulse based variational quantum optimal control is able to approximate molecular ground states of simple molecules up to chemical accuracy and is able to compete with the gate based variational quantum eigensolver in terms of total number of quantum evaluations. The total evolution time T and the form of the control Hamiltonian are important factors in the convergence behavior to the ground state energy, having influence on the quantum speed limit. Our VQOC method is able to converge to ground states of molecular problems for lower T than gate based algorithms can, mitigating decoherence effects.

DMITRY EVDOKIMOV, University of Ottawa
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 390]
Computational aspects of Optimal Transport: classical and quantum

In this talk, I will discuss the computational aspects of the classical and quantum optimal transport problems. Starting from the entropy-regularized Kantorovich problem and Sinkhorn algorithm implementations, I proceed with a quantum analog of this problem and show the experiments for solving it in the particular case of Gaussian states.

MOHAMMAD ALI AHMADPOOR JADEHKENARY, Carleton University
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 390]
Uniqueness of optimal plans for multi-marginal mass transport problems via a reduction argument

In this paper, by introducing a reduction argument, we investigate the relation between an optimal mass transport problem with N-marginals and its associated lower dimensional problems that consist of $k-$marginal problems for $k \in \mathcal{N} = \{1, \dots, N\}$. Namely, for a family of probability spaces $\{(X_k, \mathcal{B}_{X_k}, \mu_k)\}_{k=1}^N$ and a cost function $c : X_1 \times \cdots \times X_N \to \mathbb{R}$ we consider the Monge-Kantorovich problem

$$\inf_{\lambda \in \Pi(\mu_1, \dots, \mu_N)} \int_{\prod_{k=1}^N X_k} c \, d\lambda. \tag{MKP}$$

Then for each ordered subset $\mathcal{P} = \{i_1, \dots, i_p\} \subsetneq \mathcal{N}$ we create a new cost function $c_{\mathcal{P}}$ corresponding to the original cost function c defined on $\prod_{k=1}^p X_{i_k}$. This new cost function $c_{\mathcal{P}}$ enjoys many of the features of the original cost c while it has the property that any optimal plan λ of (MKP) restricted to $\prod_{k=1}^p X_{i_k}$ is also an optimal plan to the problem

$$\inf_{\tau \in \Pi(\mu_{i_1}, \dots \mu_{i_p})} \int_{\prod_{k=1}^p X_{i_k}} c_{\mathcal{P}} \, d\tau. \tag{RMKP}$$

Then, for appropriate choices of index set $\mathcal{P}$, we show that one can recover the optimal plans of (MKP) from (RMKP). Particularly, we determine situations in which the problem (MKP) admits a unique solution depending on the uniqueness of the solution to (RMKP). This allows us to prove many uniqueness results for multi-marginal problems when the unique optimal plan is not necessarily induced by a map. To this end, we extensively benefit from disintegration theorems and the c-extremality notion. Moreover, by employing the reduction method, besides recovering many standard results on the subject including the pioneering work of Gangbo-Swiech, several new applications will be demonstrated to evince the applicability of this method.

Optimal Transport in Natural and Data Sciences
La théorie du transport dans les sciences naturelles et informatiques

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ADOLFO-VARGAS JIMENEZ, University of Ottawa
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 390]
Dispersion Interactions in the Strictly Correlated Electron Limit of DFT via Multi-Marginal Optimal Transp

Multi-marginal optimal transport (MMOT) is the general problem of aligning a finite collection of probability measures to minimize some notion of overall cost. Due to its own substantial group of applications MMOT has attracted a great deal of attention. In particular, this problem with the well-known Coulomb cost has allowed the development of a mathematical framework to the strongly correlated systems in Density Functional Theory (DFT). In this talk, I will briefly introduce the mathematical settings for both MMOT and strongly correlated systems in DFT, and connect them with the dissociation limit in DFT.

This is joint work with Augusto Gerolin and Mircea Petrache.

ANNINA LIEBERHERR, University of Oxford
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 390]
Optimal Transport distances for classifying electronic excitations

In chemistry, electronic excitations may be seen as an electron moving from one energy level to another. They are heuristically divided into three groups based on certain characteristics of the involved energy levels. Knowing which group an excitation belongs to can be useful, because calculated excitation energies can vary greatly in accuracy depending on which group the excitation belongs to. On the quest to finding a systematic classification, we introduce a diagnostic based on the Sinkhorn divergence from Optimal Transport and compare it to an existing one which uses the overlap. We then apply both to a selected set of molecules and study the quality of the resulting classifiers.

NATALIIA MONINA, University of Ottawa
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 390]
Multimarginal Optimal Transport with Neural Networks

Optimal Transport problems arise naturally in many different fields such as Economics, Biology or Quantum Physics. In this talk, I will introduce the classical two-marginal optimal transport problem, and then generalize it to the problem with finitely many marginals. Finally, we will discuss computational algorithms solving the Entropy-Regularized Optimal Transport using Sinkhorn algorithm, and a novel one using Neural Networks.

BRENDAN PASS, Alberta
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 390]

Quadratic forms and Linear algebraic groups
Formes quadratiques et groupes algébriques linéaires

Org: Stefan Gille (University of Alberta) and/et **Kirill Zaynullin** (University of Ottawa)

New geometric techniques (such as intersection theory, algebraic cobordism, and motivic cohomology) have recently been introduced into the algebraic theory of quadratic forms, or more generally the study of projective homogeneous varieties and torsors over algebraic groups. This session focusses on recent developments and results, including applications to diverse areas such as Galois cohomology. Junior researchers are encouraged to apply.

De nouvelles techniques géométriques (telles que la théorie des intersections, le cobordisme algébrique et la cohomologie motivique) ont récemment été introduites dans la théorie algébrique des formes quadratiques, ou plus généralement dans l'étude des variétés homogènes projectives et des torseurs sur les groupes algébriques. Cette session se concentre sur les développements et résultats récents, y compris les applications à divers domaines tels que la cohomologie galoisienne. Les jeunes chercheurs et chercheuses sont encouragés à poser leur candidature.

Schedule/Horaire — Room/Salle: STEM 464

Saturday June 3 — samedi 3 juin

8:00 - 8:30	Danny Ofek (University of British Columbia), *On the essential dimension of cycle modules* (p. 151)
8:30 - 9:00	Eoin Mackall (University of Maryland), *(Formal) Representability of Chow groups using Milnor K-theory* (p. 151)
9:00 - 9:30	Zinovy Reichstein (University of British Columbia), *The Jordan property of Cremona groups and essential dimension* (p. 151)
9:30 - 10:00	Cameron Ruether (Memorial University), *Cohomological Obstructions to Quadratic Pairs over Schemes.* (p. 151)
10:00 - 10:30	Erhard Neher (University of Ottawa), *Knebusch's norm principle revisited* (p. 151)
15:00 - 15:30	Colin Ingalls (Carleton University), *Quasi-universal representations for finite dimensional algebras* (p. 150)
15:30 - 16:00	Nicole Lemire (Western University), *Toric Models of Algebraic Tori* (p. 151)
16:00 - 16:30	Joshua Ruiter (Michigan State), *Coding for algebraic groups* (p. 152)
16:30 - 17:00	Mikhail Kotchetov (Memorial University), *Graded algebras and quadratic forms* (p. 150)

Abstracts/Résumés

COLIN INGALLS, Carleton University
[Saturday June 3 / samedi 3 juin, 15:00 – STEM 464]
Quasi-universal representations for finite dimensional algebras

This is joint work with Emily Cliff and Charles Paquette. Given a finite dimensional algebra, we can associate a quiver and choose a dimension vector. Work of Alistair King shows that, if the dimension vector is unimodular, then given a choice of stability condition, there is a moduli space of stable representations with a universal representation. We extend this result to show that even when the dimension vector is divisible, the moduli space constructed by King has a quasi-universal representation.

MIKHAIL KOTCHETOV, Memorial University
[Saturday June 3 / samedi 3 juin, 16:30 – STEM 464]
Graded algebras and quadratic forms

In the study of group gradings on semisimple associative and Lie algebras over the fields of complex and real numbers, there appear some geometric structures on finite abelian groups, for example quadratic and alternating bilinear forms on elementary

abelian 2-groups, which can be regarded as vector spaces over the field of size 2. In this talk, based on a joint work with Alberto Elduque and Adrián Rodrigo-Escudero, we will consider the case of associative algebras with involution and explain how such structures appear and what role they play in the classification of gradings.

NICOLE LEMIRE, University of Western Ontario
[Saturday June 3 / samedi 3 juin, 15:30 – STEM 464]
Toric Models of Algebraic Tori

We discuss some explicit constructions of toric models of low-dimensional algebraic tori, following work of Kunyavskii in dimension 3. We use these constructions to understand some computational results about the birational properties of low-dimensional algebraic tori.

EOIN MACKALL, University of Maryland
[Saturday June 3 / samedi 3 juin, 8:30 – STEM 464]
(Formal) Representability of Chow groups using Milnor K-theory

We'll talk about recent work on representability (and formal representability) of various sheafifications of K-cohomology functors associated to a variety. The talk will focus on examples and speculations in particularly nice situations, for example for projective homogeneous varieties under semisimple algebraic groups over an algebraically closed field.

ERHARD NEHER, University of Ottawa
[Saturday June 3 / samedi 3 juin, 10:00 – STEM 464]
Knebusch's norm principle revisited

Given a field extension K/F of finite degree d, Knebusch's norm principle for a quadratic form q over F says that the norm of the set of non-zero values of the extended quadratic form q_K is a product of at most d nonzero values of q. We discuss this principle and some of its consequences in a setting, where the field F is replaced by a semilocal ring and the field K by a finite étale extension. The talk is based on joint work with Philippe Gille (Lyon).

DANNY OFEK, University of British Columbia
[Saturday June 3 / samedi 3 juin, 8:00 – STEM 464]
On the essential dimension of cycle modules

Essential dimension is a natural measure of complexity for algebraic objects. We will present a new elementary technique for proving lower bounds on the essential dimension of elements of cycle modules as defined by Markus Rost. Examples of cycle modules include Milnor K-theory, Quillen K-theory, Etale cohomology of torsion sheaves and more. As a corollary, we deduce the first meaningful lower bounds on the essential dimension of Brauer classes in good characteristic. This is joint work with Zinovy Reichstein.

ZINOVY REICHSTEIN, University of British Columbia
[Saturday June 3 / samedi 3 juin, 9:00 – STEM 464]
The Jordan property of Cremona groups and essential dimension

Essential dimension is an interesting numerical invariant of a finite group. In this talk I will survey the properties of this invariant and explain how advances in the Minimal Model Program lead to new insights into its asymptotic behavior.

Quadratic forms and Linear algebraic groups
Formes quadratiques et groupes algébriques linéaires

CAMERON RUETHER, Memorial University of Newfoundland
[Saturday June 3 / samedi 3 juin, 9:30 – STEM 464]
Cohomological Obstructions to Quadratic Pairs over Schemes.

The concept of quadratic pair was introduced by Knus, Merkurjev, Rost, and Tignol in The Book of Involutions to work with quadratic forms and groups of type D in characteristic 2. This notion was generalized by Calmés and Fasel to the setting of Azumaya algebras over an arbitrary base scheme, also with groups of type D in mind. We will review these definitions before discussing recent work with Philippe Gille and Erhard Neher. We define two cohomological obstructions attached to an Azumaya algebra with orthogonal involution. The weak obstruction prevents the existence of a quadratic pair, and the strong obstruction prevents potential quadratic pairs from being described as in the field/ring case. Interestingly, both these obstructions are trivial over affine schemes, and so quadratic pairs have noticeably different behaviour when working over arbitrary schemes. To demonstrate that this behaviour is possible, we will also present examples where one or both obstructions are non-trivial.

JOSHUA RUITER, Grinnell College
[Saturday June 3 / samedi 3 juin, 16:00 – STEM 464]
Coding for algebraic groups

Root systems and pinnings are vital to the structure theory of algebraic groups. Motivated by a conjecture of Borel and Tits regarding rigidity of abstract homomorphisms, it can be useful to explicitly know various structure coefficients associated to a pinning. These structure coefficients arise in commutators of root subgroups, and conjugations by Weyl group elements. I'll describe recent work with undergraduate students on building code in Matlab to calculate these kinds of structure coefficients.

Quantum Information Theory Session
Théorie de l'information quantique

Org: Jason Crann (Carleton University) and/et **Arthur Mehta** (University of Ottawa)

The aim of the session is to bring together top researchers in quantum information who are at Canadian institutions, or with close ties to Canada. Talks will focus on a variety of prominent and current topics within quantum information theory including: non-local games, quantum correlations, quantum Shannon theory, quantum resource theories, operator algebraic and categorical quantum information, and quantum cryptography. There will also be a tutorial talk on the topic of self-testing in non-local games.

Cette session se concentrera sur une variété de sujets éminents et courants dans la théorie de l'information quantique, notamment : les jeux non-locaux, les corrélations quantiques, la théorie quantique de Shannon, les théories des ressources quantiques, l'information quantique via les algèbres d'opérateurs et les catégories, et la cryptographie quantique. Il y aura également un tutoriel sur le thème de la vérification automatique dans les jeux non-locaux.

Schedule/Horaire **Rooms/Salles: LMX 360, STEM 464**

Friday June 2 — vendredi 2 juin

13:00 - 16:00	Quantum Information Theory Talk and Tutorial: Yuming Zhao (University of Waterloo), *Introduction to quantum self-testing* (p. 157), STEM 464

Saturday June 3 — samedi 3 juin

8:00 - 8:30	Ashwin Nayak (University of Waterloo), *Optimal lower bounds for Quantum Learning via Information Theory* (p. 156), LMX 360
8:30 - 9:00	Sam Harris (Northern Arizona University), *Quantum reductions of synchronous games to graph games* (p. 155), LMX 360
9:00 - 9:30	Hermie Monterde (University of Manitoba), *Low fidelity quantum transmission* (p. 156), LMX 360
9:30 - 10:00	Nathaniel Johnston (Mount Allison University), *Absolute k-Incoherence and Antidistinguishability* (p. 155), LMX 360
10:00 - 10:30	David Cui (Massachusetts Institute of Technology), *Sum-of-squares decompositions and nonlocal games* (p. 154), LMX 360
15:00 - 15:30	Sherry Wang (University of Ottawa), *Post-quantum Technologies: Password Authentication and Digital Credentials* (p. 158), LMX 360
15:30 - 16:00	Cunlu Zhou (University of New Mexico), *A singlet projector based NPA hierarchy for the quantum MAXCUT problem* (p. 158), LMX 360
16:00 - 16:30	Nicholas LaRacuente (University of Chicago), *Information Fragility or Robustness of Quantum States and Processes* (p. 155), LMX 360
16:30 - 17:00	Mahmud Azam (University of Saskatchewan), *TQFTs and Quantum Computing* (p. 154), LMX 360
17:00 - 17:30	Dave Touchette (Université de Sherbrooke) (p. 157), LMX 360
17:30 - 18:00	Debbie Leung (University of Waterloo), *Rate-Distortion Theory for Mixed States Ensembles* (p. 156), LMX 360

Sunday June 4 — dimanche 4 juin

8:00 - 8:30	Connor Paddock (University of Ottawa), *Satisfiability problems and algebras of boolean constraint system games* (p. 157), LMX 360
8:30 - 9:00	Eric Culf (University of Waterloo), *Coset states in Uncloneable Cryptography* (p. 154), LMX 360
9:00 - 9:30	Sébastien Lord (University of Ottawa), *Uncloneable Quantum Advice* (p. 156), LMX 360
9:30 - 10:00	Xiaoning Bian (Dalhousie University), *Generators and relations for 3-qubit Clifford+CS operators* (p. 154), LMX 360

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10:00 - 10:30 THOMAS THEURER (University of Calgary), *Resource theory of quantum thermodynamics: State convertibility from qubit cooling and heating* (p. 157), LMX 360

Abstracts/Résumés

MAHMUD AZAM, University of Saskatchewan
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 360]
TQFTs and Quantum Computing

Quantum computing is captured in the formalism of the monoidal subcategory M of the category $\mathrm{Vect}_{\mathbb{C}}$ of complex vector spaces generated under tensor products by $\mathbb{C}^2$ — in particular, quantum circuits can be seen as diagrams in this category — while topological quantum field theories, in the sense of Atiyah, are diagrams in $\mathrm{Vect}_{\mathbb{C}}$ indexed by a cobordism category. We outline a program to formalize a connection between these two scenarios. In doing so, we first equip cobordisms with machinery for producing $\mathbb{C}$–linear maps by parallel transport along curves under a connection and then assemble these structures into a higher category. The category M above is also given a suitable higher categorical structure which we call $\mathbb{F}\mathrm{Vect}_{\mathbb{C}}$. Finally, we realize quantum circuits as images of these cobordisms with additional structure under a higher monoidal functor to $\mathbb{F}\mathrm{Vect}_{\mathbb{C}}$, which are computed by taking parallel transports of vectors and then combining the results in a pattern encoded in the domain of the functor. This talk reports on joint work with Steven Rayan.

XIAONING BIAN, Dalhousie University
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 360]
Generators and relations for 3-qubit Clifford+CS operators

We give a presentation by generators and relations of the group of 3-qubit Clifford+CS operators. The proof roughly consists of two parts: (1) applying the Reidemeister-Schreier theorem repeatedly to an earlier result of ours; and (2) the simplification of thousands of relations into 17 relations. Both (1) and (2) have been formally verified in the proof assistant Agda. The Reidemeister-Schreier theorem gives a constructive method for computing a presentation of a sub-monoid given a presentation of the super-monoid. To achieve (2), we devise an almost-normal form for Clifford+CS operators. Along the way, we also identify several interesting structures within the Clifford+CS group. Specifically, we identify three different finite subgroups for whose elements we can give unique normal forms. We show that the 3-qubit Clifford+CS group, which is of course infinite, is the amalgamated product of these three finite subgroups. This result is analogous to the fact that the 1-qubit Clifford+T group is an amalgamated product of two finite subgroups.

DAVID CUI, Massachusetts Institute of Technology
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 360]
Sum-of-squares decompositions and nonlocal games

Any nonlocal game has an associated game polynomial representing its winning probability. Exhibiting a sum-of-squares decomposition of this game polynomial gives an upper-bound on the quantum value of the nonlocal game. Such decompositions can be numerically found via a complete hierarchy of semidefinite programs and thus are powerful tools in the theory of nonlocal games. In this talk, we'll discuss how sum-of-squares decompositions can give us self-testing results for nonlocal games and upper-bounds for multipartite games on quantum networks. This is partly based on joint work with Arthur Mehta, Hamoon Mousavi, and Sajjad Nezhadi.

Quantum Information Theory Session
Théorie de l'information quantique

ERIC CULF, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 360]
Coset states in Uncloneable Cryptography

The coset state structure has proven useful on multiple occasions in quantum information, for example in the context of the hidden subgroup problem and stabiliser codes. A basis of coset states exists for every vector subspace of a space of bitstrings, and the elements of the basis are indexed by the coset representatives of the subspace and its orthogonal complement — this provides a large amount of algebraic structure. Recently, Coladangelo, Liu, Liu, and Zhandry [Crypto 2021] introduced a monogamy-of-entanglement (MoE) game based on this structure. We extend this game to construct a variety of uncloneable cryptographic protocols.

First, we show that one of the two cooperating players can learn the other player's answer without significantly affecting the winning probability of the MoE game. This allows to construct a variety of novel cryptographic primitives including a form of uncloneable encryption where decryption uses an interaction between the sender and the receiver, and a stronger form of one-sided device independent quantum key distribution (1S DI QKD) where the receiver's classical device may also be assumed to be untrusted. Our other extension is to show that a comparable MoE property holds for coset states of a wide variety of groups, including infinite-order compact and locally compact abelian groups. This gives rise to an extension of the 1S DI QKD protocol to continuous-variable quantum systems.

This talk is based on joint work with Anne Broadbent (arxiv.org/abs/2303.00048) ; and with Victor V. Albert and Thomas Vidick (arxiv.org/abs/2212.03935).

SAM HARRIS, Northern Arizona University
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 360]
Quantum reductions of synchronous games to graph games

Synchronous games that are equivalent, in some sense, preserve certain properties about winning strategies. In this talk, we will see how one can transform any synchronous game into a graph homomorphism game. More specifically, we'll see that every synchronous game is equivalent, in some weak sense, to a three-coloring game for an associated undirected graph, and we'll give an upper bound on the number of vertices required for the graph. As a result, we will obtain a quantum version of Lovasz's reduction theorem of the k-coloring problem of a graph to the 3-coloring problem of a graph that holds in all quantum models, extending and simplifying the work of Z. Ji in the finite-dimensional model. This work uses a weak *-equivalence of games that we will describe.

NATHANIEL JOHNSTON, Mount Allison University
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 360]
Absolute k-Incoherence and Antidistinguishability

We explore the quantum resource theory of k-incoherence, in which the free states are those that can be written as a convex combination of pure states with at most k non-zero entries. In particular, we investigate the set of quantum states that can be shown to be k-incoherent based only on their eigenvalues. In analogy with the absolute separability problem, we call these states "absolutely k-incoherent", and we derive several necessary and sufficient conditions for membership in this set. As an application of our results, we derive a correct version of a recently-disproved conjecture about antidistinguishability of quantum states.

NICHOLAS LARACUENTE, University of Chicago
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 360]
Information Fragility or Robustness of Quantum States and Processes

Quantum Information Theory Session
Théorie de l'information quantique

How quickly can weak noise destroy information in a quantum system ? Several forms of this question can be phrased in terms of the ratio between initial and decayed quantum relative entropy. We consider relevant analytic properties of relative entropy, including how it relates to positive semidefinite order and von Neumann algebra inclusion indices. We emphasize regimes of extremely fast or slow decay, including when non-classical features enable such extremes.

DEBBIE LEUNG, University of Waterloo
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 360]
Rate-Distortion Theory for Mixed States Ensembles

Consider the compression of asymptotically many i.i.d. copies of ensembles of mixed quantum states where the encoder has access to a general side information system. The figure of merit is per-copy error. Rate-distortion theory studies the trade-off between the compression rate and the per-copy error. The rate-distortion function is the best compression rate given a certain distortion. In this talk, we derive the rate-distortion functions of mixed-state compression in the entanglement-assisted and unassisted scenarios, and also for the general setting where the consumption of both communication and entanglement are considered. We will discuss consequences of our results and open problems. Joint work with Zahra Baghali Khanian and Kohdai Kuroiwa.

SÉBASTIEN LORD, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 360]
Uncloneable Quantum Advice

In this work, we initiate the study of the computational complexity of cloning fixed sequences of quantum states. This is in contrast to prior studies of the no-cloning principle where the states to be copied are not fixed, but rather selected at random from some larger set.

We frame our main results as the instantiation of uncloneable quantum advice for certain specific promise problems and languages. A quantum advice state can be understood as a quantum program which is run by a user to solve a given problem instance. Thus, uncloneable quantum advice can be viewed as a contribution to the larger ongoing quest in quantum cryptography to construct copy-protection schemes for interesting functionalities. Indeed, existing quantum copy-protection schemes only offer security if the program to be copy-protected is chosen at random from some larger family. Our work establishes a proof-of-principle that a version of copy-protection for fixed and specific programs is achievable.

Joint work with Anne Broadbent and Martti Karvonen.

HERMIE MONTERDE, University of Manitoba
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 360]
Low fidelity quantum transmission

A quantum spin network is modelled by an undirected graph X, where the vertices and edges of X represent the qubits in the network and their interactions, respectively. The fidelity (probability) of quantum state transfer from vertex u to vertex v at time t is given by the modulus of the (u, v) entry of the unitary operator $U(t) = \exp(itH)$, where H is the Hamiltonian of the quantum system. Most studies focus on high fidelity quantum transmission between distinct vertices in a graph (such as perfect state transfer and pretty good state transfer). In this talk, we discuss low fidelity quantum transmission and provide several infinite families of graphs that exhibit such a property. This talk is based on the paper *https://arxiv.org/abs/2303.06297*.

ASHWIN NAYAK, University of Waterloo
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 360]
Optimal lower bounds for Quantum Learning via Information Theory

Quantum Information Theory Session
Théorie de l'information quantique

We revisit two problems in learning theory, in which the goal is to learn some property given copies ("samples") of the same quantum state. We derive optimal lower bounds on the number of samples required to solve these problems, using a combination of algebraic and information-theoretic techniques. The resulting proofs are both simpler and shorter than those given before.

(Based on work with Shima Bab Hadiashar and Pulkit Sinha.)

CONNOR PADDOCK, University of Ottawa

[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 360]

Satisfiability problems and algebras of boolean constraint system games

Properties of boolean constraint system (BCS) algebras characterize various types of perfect entangled strategies for BCS nonlocal games. These different types of perfect strategies suggest various generalized notions of satisfiability for constraint systems. We construct a constraint system which is C^*-satisfiable but not tracially satisfiable. We show that reductions between constraint systems can be captured as homomorphisms between BCS algebras, and use this point of view to streamline and strengthen several results of Atserias, Kolaitis, and Severini [AKS'19]. In particular, we show that the question of whether there is a hyperlinear group is linked to proving dichotomy theorems for $\mathcal{R}^{\mathcal{U}}$-satisfiability of constraint systems. We also point out a number of additional open problems with other types of satisfiability.

QUANTUM INFORMATION THEORY TALK AND TUTORIAL: YUMING ZHAO, University of Waterloo

[Friday June 2 / vendredi 2 juin, 13:00 – STEM 464]

Introduction to quantum self-testing

Suppose we have a physical system consisting of two separate labs, each capable of making a number of different measurements. If the two labs are entangled, then the measurement outcomes can be correlated in surprising ways. In quantum mechanics, we model physical systems like this with a state vector and measurement operators. However, we do not directly see the state vector and measurement operators, only the resulting measurement statistics (which are referred to as a *correlation*). There are typically many different models achieving a given correlation. Hence it is a remarkable fact that some correlations have a unique quantum model. A correlation with this property is called a self-test.

This tutorial will offer an introduction to self-testing and relevant mathematics. Particular focus will be given to the operator-algebraic perspective of understanding self-testing and the use of approximate representation theory in proving robustness.

THOMAS THEURER, University of Calgary

[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 360]

Resource theory of quantum thermodynamics: State convertibility from qubit cooling and heating

Thermodynamics plays an important role both in the foundations of physics and in technological applications. An operational perspective adopted in recent years is to formulate it as a quantum resource theory. I will begin with a quick introduction to the general framework of quantum resource theories, in particular motivating it and explaining why the convertibility of resourceful states is at its core. I will then specialize to the resource theory of quantum thermodynamics and present recent results that I found in collaboration with Elia Zanoni, Carlo Maria Scandolo, and Gilad Gour: We solved the question of how in the quantum limit, thermal non-equilibrium can be used to heat and cool other quantum systems that are initially at thermal equilibrium. We then showed that the convertibility between quasi-classical resources (resources that do not exhibit coherence between different energy eigenstates) is fully characterized by their ability to cool and heat qubits, i.e., by two of the most fundamental thermodynamical tasks on the simplest quantum systems. We, therefore, characterized the core problem of the resource theory of thermodynamics with operationally relevant tasks.

Quantum Information Theory Session
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DAVE TOUCHETTE, Université de Sherbrooke
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 360]

SHERRY WANG, University of Ottawa
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 360]
Post-quantum Technologies: Password Authentication and Digital Credentials

In a post-quantum world, where attackers may have access to full-scale quantum computers, all public key cryptosystems will be compromised. In this talk, we'll look at two possible post-quantum-secure systems. We'll look at an implementation of a password authentication scheme on a quantum computer. Briefly, we'll also talk about post-quantum digital credentials, which are a privacy technology that allows users to disclose information about an attribute without revealing the attribute itself during transactions.

CUNLU ZHOU, University of New Mexico
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 360]
A singlet projector based NPA hierarchy for the quantum MAXCUT problem

The QMA-hard quantum MAXCUT (QMC) problem, a quantum analog of the classical MAXCUT problem, studies the maximum eigenvalue of the so-called anti-ferromagnetic Heisenberg model. The quantum Heisenberg model plays a central role in condensed matter physics for understanding quantum magnetism and is one of the simplest models that exhibit genuine quantum computational hardness. The NPA hierarchy is the quantum (noncommutative) analog of the Lasserre hierarchy, which consists of a sequence of converging semidefinite programming (SDP) relaxations and has played an important role in studying combinatorial optimization problems. In this talk, I will introduce an NPA hierarchy for QMC based on the singlet projectors (projectors of the form $h = |\psi^-\rangle\langle\psi^-|$, where $|\psi^-\rangle = \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle)$). The singlet projector follows the $SU(2)$ symmetry naturally, and the obtained NPA hierararchy is conceptually simpler and practically implementable. I will show several analytic and computational results concerning this new hierarchy.

(Based on work with Jun Takahashi, Chaithanya Rayudu, Robbie King, Kevin Thompson, and Ojas Parekh.)

Recent Advances in Mathematical Finance
Progrès récents en finance mathématique

Org: Alexandru Badescu (University of Calgary) and/et **Cody Hyndman** (Concordia University)

Mathematical Finance considers models, pricing, and management of financial variables ; contracts, risks, and markets. The session includes, but is not limited to, talks on: stochastic modelling of financial assets ; pricing and hedging derivative securities ; term-structure of interest rates ; portfolio management ; credit risk ; arbitrage theory ; volatility forecasting ; market microstructure and price formation ; and computational methods and applications of machine learning in finance.

La finance mathématique s'intéresse aux modèles, à la tarification et à la gestion des variables financières, aux contrats, aux risques et aux marchés. La session comprend, sans s'y limiter, des exposés sur : la modélisation stochastique des actifs financiers ; l'évaluation et la couverture des titres dérivés ; la structure des taux d'intérêt ; la gestion de portefeuille ; le risque de crédit ; la théorie de l'arbitrage ; la prévision de la volatilité ; la microstructure du marché et la formation des prix ; et les méthodes informatiques et les applications de l'apprentissage automatique dans le domaine de la finance.

Schedule/Horaire **Room/Salle: LMX 405**

Saturday June 3 / samedi 3 juin

8:00 - 8:30	Matheus Grasselli (McMaster University), *Green monetary policy* (p. 162)
8:30 - 9:00	Mark Reesor (Wilfrid Laurier University), *Incorporating Climate Risk into Portfolio Credit Risk Models via Distortion* (p. 164)
9:00 - 9:30	Maciej Augustyniak (Université de Montréal), *A Discrete-Time Hedging Framework for Econometric Option Pricing Models* (p. 160)
9:30 - 10:00	Jean-François Bégin (Simon Fraser University), *A general option pricing framework for affine fractionally integrated models* (p. 160)
10:00 - 10:30	François Watier (UQAM), *A Weighted Mean-Variance Portfolio Under a No-Bankruptcy Constraint* (p. 165)
15:00 - 15:30	Clarence Simard (UQAM), *Optimal dividend with a proportional bound in a Brownian model* (p. 165)
15:30 - 16:00	Jean-François Renaud (UQAM), *Maximization of dividend payments with a concave bound on the dividend rate* (p. 164)
16:00 - 16:30	Alexandre Roch (ESG UQAM), *Optimal dividend and capital injection strategies : a viscosity approach* (p. 164)
16:30 - 17:00	Anne Mackay (Université de Sherbrooke), *Optimal stopping with a discontinuous and time-dependent reward function* (p. 163)
17:00 - 17:30	Frédéric Godin (Concordia University), *Risk allocation through Shapley decompositions with applications to variable annuities* (p. 162)
17:30 - 18:00	Adam Metzler (Wilfrid Laurier University), *(Machine) Learning From Transaction-Level Investment Account Data* (p. 164)

Sunday June 4 / dimanche 4 juin

8:00 - 8:30	Dena Firoozi (HEC Montréal), *LQG Risk-Sensitive Mean Field Games with a Major Agent* (p. 161)
8:30 - 9:00	Anastasis Kratsios (McMaster University), *Designing Universal Causal Deep Learning Models: The Geometric (Hyper)Transformer* (p. 162)
9:00 - 9:30	Christoph Frei (University of Alberta), *Principal Trading Arrangements: Optimality under Temporary and Permanent Price Impact* (p. 161)
9:30 - 10:00	Roman Makarov (Wilfrid Laurier University), *Structural Credit Risk Models with Occupation Times and Spectral Expansions* (p. 163)
10:00 - 10:30	Antony Ware (University of Calgary), *Multi-factor polynomial models for energy commodity markets* (p. 165)
15:00 - 15:30	David Saunders (University of Waterloo), *Bounds on Choquet Integrals in Finite Product Spaces for Capacities with Given Marginals* (p. 165)

15:30 - 16:00	Luca Lalor (Calgary), *A Numerical Solution to an Algorithmic and HFT Problem with a Jump-Diffusion Price Process* (p. 163)
16:00 - 16:30	Ziteng Cheng (Toronto), *Mean field regrets in discrete time games* (p. 161)
16:30 - 17:00	Louis Arsenault-Mahjoubi (SFU), *Discrete nonlinear filtering in finance: Applications to stochastic volatility models with jumps* (p. 160)
17:00 - 17:30	Kirill Golubnichiy (Calgary), *Ill-Posed Problem for the Black-Scholes Equation solution and Machine Learning* (p. 162)

Abstracts/Résumés

LOUIS ARSENAULT-MAHJOUBI, Simon Fraser University
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 405]
Discrete nonlinear filtering in finance: Applications to stochastic volatility models with jumps

The estimation of complex financial models such as jump-diffusion models is often performed using sophisticated filtering methods. The discrete nonlinear filter (DNF) provides a deterministic, quick, and flexible alternative to the popular particle filter. Recently, researchers have developed a high-dimensional version of the DNF for jump-diffusion models. In this talk, I outline how the filter is applicable for both frequentist and Bayesian estimation, areas where it is particularly effective compared to alternative approaches (e.g., joint estimation with options and returns data), and its limitations (e.g., models with multiple persistent latent variables). Moreover, I will provide evidence of its effectiveness from simulation studies, empirical results from S&P 500 returns, and a brief overview of the SVDNF R package, which makes the DNF available for returns-only estimation of one-factor stochastic volatility models.

MACIEJ AUGUSTYNIAK, University of Montreal
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 405]
A Discrete-Time Hedging Framework for Econometric Option Pricing Models

We present a quadratic hedging framework for a general class of discrete-time affine multi-factor models. A semi-explicit hedging formula is derived for our general framework which applies to a myriad of the option pricing models proposed in the discrete-time literature, including the multi-component fat-tailed GARCH model, the Lévy GARCH model, the affine realized volatility (GARV) model, and the heterogeneous autoregressive gamma (HARG) model for realized volatility. Additionally, we conduct an extensive empirical study of the impact of modelling features on the hedging effectiveness of S&P 500 options. Overall, we find that fat tails can be credited for half of the hedging improvement observed, while a second volatility factor and a non-monotonic pricing kernel each contribute to a quarter of this improvement. Interestingly, our study indicates that the added value of these features for hedging is different than for pricing. A robustness analysis shows that a similar conclusion can be reached when considering the Dow Jones Industrial Average. The talk will also cover some extensions of our methodology that incorporate stochastic interest rates and basis risk.

JEAN-FRANÇOIS BÉGIN, Simon Fraser University
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 405]
A general option pricing framework for affine fractionally integrated models

This article studies the impact of fractional integration on volatility modelling and option pricing. We propose a general discrete-time pricing framework based on affine multi-component volatility models that admit ARCH(∞) representations. This not only nests a large variety of option pricing models from the literature, but also allows for the introduction of novel

covariance-stationary long-memory affine GARCH pricing models. Using an infinite sum characterization of the log-asset price's cumulant generating function, we derive semi-explicit expressions for the valuation of European-style derivatives under a general variance-dependent stochastic discount factor. Moreover, we carry out an extensive empirical analysis using returns and S&P 500 options over the period 1996–2019. Overall, we find that once the informational content from options is incorporated into the parameter estimation process, the inclusion of fractionally integrated dynamics in volatility is beneficial for improving the out-of-sample option pricing performance. The largest improvements in the implied volatility root-mean-square errors occur for options with maturities longer than one year, reaching 33% and 13% when compared to standard one- and two-component short-memory models, respectively.

ZITENG CHENG, University of Toronto
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 405]
Mean field regrets 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 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 distribution 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.

DENA FIROOZI, HEC Montréal - Université de Montréal
[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 405]
LQG Risk-Sensitive Mean Field Games with a Major Agent

Risk sensitivity plays an important role in the study of finance and economics as risk-neutral models cannot capture and justify all economic behaviors observed in reality. Risk-sensitive mean field game theory was developed recently for systems where there exists a large number of indistinguishable, asymptotically negligible and heterogeneous risk-sensitive players, who are coupled via the empirical distribution of state across population (average state of the population in the LQG case). In this work, we extend the theory of LQG risk-sensitive MFGs to the setup where there exists one major agent as well as a large number of minor agents. The major agent has a significant impact on each minor agent and its impact does not collapse with the increase in the number of minor agents. Each agent is subject to linear dynamics with an exponential-of-integral quadratic cost functional. Moreover, all agents interact via the average state of minor agents (so-called empirical mean field) and the major agent's state. We use a change of measure technique together with a variational analysis to derive the 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.

CHRISTOPH FREI, University of Alberta
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 405]
Principal Trading Arrangements: Optimality under Temporary and Permanent Price Impact

We study the optimal execution problem in a principal-agent setting. A client (for example, a pension fund, endowment, or other institution) contracts to purchase a large position from a dealer at a future point in time. In the interim, the dealer acquires the position from the market, choosing how to divide his trading across time. Price impact may have temporary and permanent components. There is hidden action in that the client cannot directly dictate the dealer's trades. Rather, she chooses a contract with the goal of minimizing her expected payment, given the price process and an understanding of the dealer's incentives. Many contracts used in practice prescribe a payment equal to some weighted average of the market prices within the execution window. We explicitly characterize the optimal such weights: they are symmetric and generally U-shaped over

time. The talk is based on joint work with Markus Baldauf (University of British Columbia) and Joshua Mollner (Northwestern University).

FRÉDÉRIC GODIN, Concordia University
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 405]
Risk allocation through Shapley decompositions with applications to variable annuities

A flexible risk decomposition method for life insurance contracts embedding several risk factors is introduced. Hedging can be naturally embedded in the framework. Although the method is applied to variable annuities in this work, it is also applicable in general to other insurance or financial contracts. The approach relies on applying an allocation principle to components of a Shapley decomposition of the gain and loss. The implementation of the allocation method requires a stochastic on stochastic algorithm. Numerical examples studying the relative impact of equity, interest rate and mortality risk for guaranteed minimal maturity benefit (GMMB) policies conclude our analysis.

KIRILL GOLUBNICHIY, University of Calgary
[Sunday June 4 / dimanche 4 juin, 17:00 – LMX 405]
Ill-Posed Problem for the Black-Scholes Equation solution and Machine Learning

In the previous paper (Inverse Problems, 32, 015010, 2016), a new heuristic mathematical model was proposed for accurate forecasting of prices of stock options for 1-2 trading days ahead of the present one. 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. To enhance these results, the Neural Network Machine Learning is applied on the second stage. Real market data are used. Results of Quasi-Reversibility Method and Machine Learning method are compared in terms of accuracy, precision and recall.

MATHEUS GRASSELLI, McMaster University
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 405]
Green monetary policy

It is well documented that climate change adaptation and mitigation, including the transition to net zero emissions, require financial flows that are several times larger than what is currently observed. In this talk, I review a stock-flow consistent climate-economy model and explain the inherent instability associated with balancing the effects of economic damages caused by climate change and the financial burden incurred to prevent them. I then present a modification of the model that takes into account two different monetary policies that could be implemented by central banks in order to improve the stability of the system: green quantitative easing (that is to say, large scale purchases of financial instruments used to fund green investment) and green capital requirements (that is, measures aimed at making loans for green projects more attractive for banks to hold in their balance sheets). I illustrate the stabilization effects of these polices with examples calibrated to data and similar proposals in the literature.

ANASTASIS KRATSIOS, McMaster
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 405]
Designing Universal Causal Deep Learning Models: The Geometric (Hyper)Transformer

Several problems in stochastic analysis are defined through their geometry, and preserving that geometric structure is essential to generating meaningful predictions. Nevertheless, how to design principled deep learning (DL) models capable of encoding

these geometric structures remains largely unknown. We address this open problem by introducing a universal causal geometric DL framework in which the user specifies a suitable pair of metric spaces X and Y and our framework returns a DL model capable of causally approximating any "regular" map sending time series in XZ to time series in YZ while respecting their forward flow of information throughout time. Suitable geometries on Y include various (adapted) Wasserstein spaces arising in optimal stopping problems, a variety of statistical manifolds describing the conditional distribution of continuous-time finite state Markov chains, and all Fréchet spaces admitting a Schauder basis, e.g. as in classical finance. Suitable spaces X are compact subsets of any Euclidean space. Our results all quantitatively express the number of parameters needed for our DL model to achieve a given approximation error as a function of the target map's regularity and the geometric structure both of X and of Y. Even when omitting any temporal structure, our universal approximation theorems are the first guarantees that Hölder functions, defined between such X and Y can be approximated by DL models.

Joint work with: Beatrice Acciaio, Gudmund Pammer

Available at: doi/full/10.1111/mafi.12389

LUCA LALOR, University of Calgary

[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 405]

A Numerical Solution to an Algorithmic and HFT Problem with a Jump-Diffusion Price Process

The main subject of this talk is to introduce an algorithmic and High-Frequency Trading model where the price process is of the jump-diffusion type. This talk begins with a brief introduction on how to apply Stochastic Optimal Control theory to algorithmic trading problems. A price process in the Jump-Diffusion setting is then introduced along with its infinitesimal generator, which encompasses one of the major modelling adjustments in this research. Previous research modelled the jumps through a diffusion approximation, while here the jumps are modelled directly. Preliminary results, using an Implicit-Explicit Finite Difference Scheme, for an Optimal Acquisition algorithmic trading problem will be presented. Here the jump part of the Jump-Diffusion price process will be a function of a Poisson process. This talk will end with a discussion on proposed modifications to the discussed algorithmic trading problem, so that the future models will account for the non-Markovian property seen in LOB data.

ANNE MACKAY, Université de Sherbrooke

[Saturday June 3 / samedi 3 juin, 16:30 – LMX 405]

Optimal stopping with a discontinuous and time-dependent reward function

We consider a financial derivative with early exercise whose reward function is time-dependent, unbounded and presents a discontinuity at maturity. In this context, the regularity conditions required to apply the results and techniques used in the American option literature are not satisfied. We confirm the existence of an optimal stopping time, and show that our problem admits a trivial optimal stopping time under certain conditions. We show that the value function admits another representation in terms of a continuous reward function, which allows us to express the price of our derivative as a free boundary value problem. We also present an integral expression for the early exercise premium and an application of our results to the problem of optimal surrender in variable annuities.

ROMAN MAKAROV, Wilfrid Laurier University

[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 405]

Structural Credit Risk Models with Occupation Times and Spectral Expansions

We propose a class of structural credit risk models with liquidation barriers and hazard rates based on occupation times. The defaults within the models are characterized in accordance with Chapter 7 (a liquidation process) and Chapter 11 (a reorganization process) of the U.S. Bankruptcy Code. The risk-neutral default probabilities involve joint probability distributions of the underlying firm's value with imposed killing at the liquidation barrier and its occupation time with respect to the reorganization barrier. The joint probability distributions are expressed as spectral series expansions, which allow us to write

pricing formulas for credit derivatives and credit default swap (CDS) spreads explicitly as infinite series that converge rapidly. The spectral methodology works for solvable diffusion, such as the geometric Brownian motion (GBM), the constant elasticity of variance (CEV) process and other state-dependent volatility diffusion models. We then calibrated our model with a GBM governing the firm's value to market CDS spreads from the Total Energy company. Our calibration results show that the computations are fast, and the fit is nearly perfect.

This is a joint work with Giuseppe Campolieti and Hiromichi Kato.

ADAM METZLER, Wilfrid Laurier University
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 405]
(Machine) Learning From Transaction-Level Investment Account Data

In this talk I will give a high-level overview of several recent projects related to a rich set of transaction-level data from individual investment accounts. Time permitting I will touch on (i) clustering individuals based on their trading behaviour, (ii) assessing the degree to which client behaviour aligns with professional advice, (iii) understanding the relationship between savings habits and investment outcomes and (iv) the extent to which professional advice can be replicated by classification algorithms.

MARK REESOR, Wilfrid Laurier Universtiy
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 405]
Incorporating Climate Risk into Portfolio Credit Risk Models via Distortion

Regulatory requirements are evolving towards mandating financial institutions to estimate and report their climate-related financial risks. Climate risks classify into two broad categories — physical and transition — and, being medium- to long-term in nature, they are important risk factors for credit portfolios. Threshold models for portfolio credit risk specify account level models with both systematic and idiosyncratic effects. These aggregate to generate the portfolio loss distribution from which risk metrics are calculated. Augmenting the systematic factor with climate factors is one method to incorporate climate risk into existing models. Distortion provides a method for re-weighting a probability distribution. The amount of deformation depends on the choice of distortion function and its parameter. Here, we propose distortion as a way of incorporating climate risk into existing credit risk models. Some properties of the distorted credit risk models are derived and explored. The connection between distortion functions and constrained relative entropy optimisation provides insight into distortion function structure and parameter values. This is joint work with Arie Zeldenrijk, Mark Drmac, and Walid Mnif.

JEAN-FRANÇOIS RENAUD, UQAM
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 405]
Maximization of dividend payments with a concave bound on the dividend rate

In a Brownian model, we revisit Bruno de Finetti's optimal dividends problem for absolutely continuous strategies by imposing a path-dependent concave bound on the rate of dividend payments. This is a generalization of the classical version of this problem as studied by Jeanblanc and Shiryaev (1995) and in which the rate is uniformly bounded. Our main result consists in proving that a so-called mean-reverting strategy is optimal. Then, we consider the associated bail-out optimization problem in which the cash process must be kept solvent. Again, we obtain that it is optimal to pay out dividends using a mean-reverting strategy, while bail-out payments are made to avoid bankruptcy.

This talk is based on joint papers with Félix Locas, Alexandre Roch and Clarence Simard.

ALEXANDRE ROCH, UQAM
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 405]
Optimal dividend and capital injection strategies : a viscosity approach

We consider the problem of finding the optimal dividend and capital injection strategies for a firm for which the cash (surplus) process is driven by Brownian motion. Dividend processes are assumed to be absolutely continuous whereas capital injections are only assumed to be adapted and non decreasing. We show that when it is only optimal to inject capital, we only do so to avoid bankruptcy. Using the theory of viscosity solutions and dynamic programming, we show that the value function is the unique viscosity solution of an associated HJB variational inequality. We characterize the optimal dividend strategy in terms of a threshold solution. We prove a comparison theorem for viscosity solutions which is used to show that the optimal solution to the problem is dichotomic : either we inject capital to avoid bankruptcy in the minimal way, or we never inject and let the firm default when the cash process hits zero.

This talk is based on joint work with and builds on previous talks by Jean-François Renaud and Clarence Simard.

DAVID SAUNDERS, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 405]
Bounds on Choquet Integrals in Finite Product Spaces for Capacities with Given Marginals

We investigate the problem of finding upper and lower bounds for a Choquet risk measure of a nonlinear function of two risk factors, when the marginal distributions of the risk factors are ambiguous and represented by nonadditive measures on the marginal spaces, but the joint nonadditive distribution on the product space is unknown. We treat this problem as a generalization of the optimal transportation problem to the setting of nonadditive measures. We provide explicit characterizations of the optimal solutions for finite marginal spaces, and we investigate some of their properties. We further discuss the connections with linear programming, showing that the optimal transport problems for capacities are linear programs, and we also characterize their duals explicitly.

CLARENCE SIMARD, Université du Québec à Montréal
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 405]
Optimal dividend with a proportional bound in a Brownian model

We study the problem of dividend optimization when the value of the firm is a Brownian motion with drift and the rate of dividend is bounded by a percentage of the firm's value. We will see that the optimal dividend strategy is a bridge between the optimal strategy when dividends are unbounded, derived in Jeanblanc and Shiryaev (1995), and the mean-reverting strategy studied in Avanzi and Wong (2012).

ANTONY WARE, University of Calgary
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 405]
Multi-factor polynomial models for energy commodity markets

In the context of energy commodity price modelling, prices are often formed from exponential maps of underlying factor processes, motivated in part by the mathematical convenience this offers. In this talk we will focus on multi-factor models based on polynomial maps of polynomial processes (PMPP models), and explore how they can function in a similar way, retaining much of the mathematical convenience of the exponential map, and providing additional flexibility, such as the ability to capture negative prices in a natural way, or to model prices with intrinsic upper bounds. And this additional level of flexibility means that PMPP models are capable of capturing the extreme dynamics that are commonly seen in energy market prices even with relatively tame dynamics in the underlying factor process.

Polynomial processes have the property that the expectation of a polynomial map of the process value at a future time T, conditional on its value at an earlier time t, is also a polynomial map of the same (or lower) degree. In the context of PMPP models, this property means that futures prices can be computed via multiplication by a (typically small) matrix. We will demonstrate how this works in practice, and show how option prices can also be computed in semi-closed form, using techniques that open the door to other applications.

FRANÇOIS WATIER, Université du Québec à Montréal
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 405]
A Weighted Mean-Variance Portfolio Under a No-Bankruptcy Constraint

In the context of a continuous-time Black-Scholes market model, we consider a stochastic portfolio management problem where the investor wishes to reach an expected terminal wealth while minimizing a skewed mean-variance risk measure, that is more weight (or penalty) is given on downside returns. Under a positive wealth constraint, we show that there exists an explicit optimal strategy given in feedback form.

Joint work with Rene Ferland

Set theory and its applications
Théorie des ensembles et ses applications

Org: Marcin Sabok (McGill University) and/et **Ilian Smythe** (University of Winnipeg)

Set theory traditionally serves as a foundation for mathematics and as the rigorous study of the infinite, however its role as a tool in other parts of mathematics has blossomed in recent decades. This session will invite researchers to speak on applications of set theory to a wide variety of different areas such as combinatorics, Banach spaces, operator algebra, topology, dynamics, and ergodic theory, as well as on topics in pure set theory.

La théorie des ensembles sert traditionnellement de fondement aux mathématiques et d'étude rigoureuse de l'infini, mais son rôle en tant qu'outil dans d'autres parties des mathématiques s'est développé au cours des dernières décennies. Cette session invitera les chercheurs à parler des applications de la théorie des ensembles à une grande variété de domaines différents tels que la combinatoire, les espaces de Banach, les algèbres d'opérateurs, la topologie, la dynamique et la théorie ergodique, ainsi que de sujets relatifs à la théorie pure des ensembles.

Schedule/Horaire **Room/Salle: LMX 258**

Saturday June 3 **samedi 3 juin**

8:30 - 9:00	Keegan Dasilva Barbosa (University of Toronto), *Box Ramsey and Canonical Partitions* (p. 168)
9:00 - 9:30	Davoud Abdi (University of Calgary), *Counterexample to Conjectures of Bonato-Tardif, Thomassé and Tyomkyn, Future Directions* (p. 167)
9:30 - 10:00	Antoine Poulin (McGill University), *Borel complexity of Archimedean orders on finitely generated group* (p. 169)
10:00 - 10:30	Ruiyuan Chen (University of Michigan), *Quasi-treeable equivalence relations* (p. 168)
15:00 - 15:30	Christopher Karpinski (McGill University), *Hyperfiniteness of boundary actions of groups* (p. 168)
15:30 - 16:00	Samuel Mellick (McGill), *Higher rank groups have fixed price one* (p. 168)
16:00 - 16:30	Allison Wang (Carnegie Mellon University), *Every CBER is smooth below the Carlson-Simpson generic partition* (p. 170)
16:30 - 17:00	Spencer Unger (University of Toronto), *Flows on the torus* (p. 170)

Sunday June 4 **dimanche 4 juin**

8:30 - 9:00	Brian Pinsky (Rutgers University), *Groups which are not Automorphism Groups of Graphs* (p. 169)
9:00 - 9:30	Christopher Eagle (University of Victoria), *Counting models of theories in non-first-order logics* (p. 168)
9:30 - 10:00	Diana Carolina Montoya (Technical University of Vienna), *Maximal independence and singular cardinals* (p. 169)
10:00 - 10:30	Asger Tornquist (University of Copenhagen), *Almost disjoint families in higher dimensions* (p. 169)

Abstracts/Résumés

DAVOUD ABDI, University of Calgary
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 258]
Counterexample to Conjectures of Bonato-Tardif, Thomassé and Tyomkyn, Future Directions

Two structures R and S are called *equimorphic* when each embeds in the other; we may also say that one is a *sibling* of the other. Equimorphic finite structures are necessarily isomorphic, but this is no longer the case for infinite structures. For instance, the rational numbers, considered as a linear order, has continuum many siblings, up to isomorphism. Thomassé (2000) conjectured that a countable relation has either one, countably or continuum many siblings, up to isomorphism. There is a

special case of interest stating that a relational structure of any cardinality has one or infinitely many siblings. This is connected to a conjecture of Bonato-Tardif stating that a tree has one or infinitely many siblings.

In this talk we introduce the conjectures mentioned and those structures for which the conjectures have been verified by giving historical progress. Then, we introduce a counterexample to the conjectures and state open problems in the sibling program.

KEEGAN DASILVA BARBOSA, Fields Institute
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 258]
Box Ramsey and Canonical Partitions

The KPT correspondence gives a full characterization of the dynamics of automorphism groups of Fraïssé structures through finite combinatorics. There is still much open however on whether or not there is a full correspondence between big Ramsey degrees and topological dynamics. While a partial answer has been found by Zucker by considering structures that admit a big Ramsey structure, the question still remains open. Motivated by this problem, we aim to answer a related question. Namely, what are the necessary and sufficient conditions needed for a structure to admit a finite list of canonical relations ? We do so by developing a natural productive analogue to big Ramsey we call the Box Ramsey degree, solving a question of Masulovic. Our techniques will be reminiscent of Rado's proof of the Erdös-Rado theorem, or more recently, works on canonical equivalence relations done by Laflamme, Sauer, and Vuksanovic.

RUIYUAN CHEN, University of Michigan
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 258]
Quasi-treeable equivalence relations

A countable Borel equivalence relation is said to be treeable if there is a Borel assignment of a tree on each equivalence class. We prove various results showing that every Borel assignment of "large-scale approximate trees" can be turned into genuine trees, thereby yielding new sufficient criteria for treeability. Joint with Antoine Poulin, Ran Tao, and Anush Tserunyan.

CHRISTOPHER EAGLE, University of Victoria
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 258]
Counting models of theories in non-first-order logics

In 1970 Morley proved that a countable first-order theory has either at most $\aleph_1$ many or exactly $2^{\aleph_0}$ many isomorphism classes of countable models, regardless of the value of $2^{\aleph_0}$. Ideas implicit in Morley's proof give the stronger fact that if a countable first-order theory has strictly more than $\aleph_1$ isomorphism classes of countable models then it has a perfect set of pairwise non-isomorphic countable models. We consider the possible number of isomorphism classes of countable models, and whether there are perfect sets of non-isomorphic models, for theories of several stronger logics (including second-order logic, logics with game quantifiers, and logics with partially ordered quantifiers). For second-order theories we show that the statement analogous to Morley's result is independent of ZFC. This talk is based on joint work with Clovis Hamel, Sandra Müller, and Frank Tall.

CHRISTOPHER KARPINSKI, McGill University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 258]
Hyperfiniteness of boundary actions of groups

Hyperbolic groups and the more general relatively hyperbolic groups are classes of "negatively curved groups" that are a focal point in geometric group theory. These groups come equipped with a natural boundary at infinity, which is a compact metrizable space on which the group acts. After a brief introduction to hyperbolic and relatively hyperbolic groups, we outline the core ideas behind proving that the orbit equivalence relations of the natural actions of hyperbolic and relatively hyperbolic groups on their boundaries are particularly simple from the point of view of descriptive set theory, namely, that they are hyperfinite.

Set theory and its applications
Théorie des ensembles et ses applications

SAMUEL MELLICK, McGill
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 258]
Higher rank groups have fixed price one

Cost is a fundamental invariant in measured group theory, generalising the notion of "rank" (in the sense of the minimum number of generators for a group). A group is said to have "fixed price" if all of its actions have the same cost. In recent work, we have been able to show that "higher rank" groups (such as $\mathrm{SL}_3(\mathbb{R})$ and $\mathrm{Aut}(T) \times \mathrm{Aut}(T)$) have fixed price one. This implies, for instance, that lattices in $\mathrm{SL}_3(\mathbb{R})$ admit generating sets of size little-o of their covolume, resolving a conjecture of Abert-Gelander-Nikolov. It also implies state of the art vanishing results for mod-p Betti numbers. A key ingredient in the argument is analysis of a new object from probability theory, the "Ideal Poisson-Voronoi tessellation" (IPVT). In higher rank, this object has truly bizarre properties.
I will give an overview of cost and sketch the structure of the argument. No prior familiarity with cost or the requisite probability theory will be assumed.
Joint work with Mikolaj Fraczyk and Amanda Wilkens.

DIANA CAROLINA MONTOYA, Technische Universität Wien
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 258]
Maximal independence and singular cardinals

In this talk, we will deal with the concept of a maximal δ-independent family of subsets of λ, when λ is a singular cardinal of cofinality κ and δ is a regular cardinal $\leq \kappa$. We will show that if λ is a singular cardinal which is a limit of a sequence of regular cardinals $(\lambda_\alpha : \alpha < \kappa)$ and there are maximal δ-independent families at each cardinal λ_α ; then it is possible to build a maximal δ-independent family at the singular λ. Afterward, we will use this fact together with the results of Kunen regarding the existence of maximal independent families at regular cardinals to prove our main result: If λ is a singular cardinal which is a limit of supercompact cardinals $(\lambda_\alpha : \alpha < \kappa)$ and $cof(\lambda) = \kappa$, then consistently there exists a maximal κ-independent family of subsets of λ. Finally, we add a discussion on the possible sizes of these families.

BRIAN PINSKY, Rutgers University
[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 258]
Groups which are not Automorphism Groups of Graphs

Frucht's theorem states every group is the automrophism group of a graph. This was shown in ZFC in 1960. We show Frucht's theorem also holds in ZF, by a similar proof, but that the proof critically relies on foundation.

In ZFA set theory (ZF with atoms), we will show Frucht's theorem can fail, and there are counterexamples in many common permutation models. Frucht's theorem can also hold in ZFA for non-trivial reasons, as happens in the ordered Mostowski model. We will examine Frucht's theorem over ZFA, and talk about what this might mean for models of ZF.

ANTOINE POULIN, McGill
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 258]
Borel complexity of Archimedean orders on finitely generated group

We present results on the Borel complexity of the action of $GL_2(\mathbb{Z})$ on the Archimedean orders of $\mathbb{Z}^2$. This mimics a result of F. Calderoni, A. Shani, D. Marker and L. Motto Ros for $\mathbb{Q}^2$. We discuss possible generalizations to different groups, including for intermediate rings $\mathbb{Z} \subset R \subset \mathbb{Q}$ and $\mathbb{Z}^n$.

ASGER TORNQUIST, University of Copenhagen, Denmark
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 258]
Almost disjoint families in higher dimensions

A classical almost disjoint family is a family of subsets of the natural numbers such that any two non-identical elements of the family intersect finitely, that is, their intersection is in the ideal FIN. A "mad family" is, of course, a maximal almost disjoint family. Definability problems related to classical mad families have been studied intensively in the past few years. This talk is about extending and generalizing the classical notion of an almost disjoint family by replacing the ideal of finite sets FIN with other ideals, and in this talk, this specifically means replacing it with the iterated Frechet ideals FIN^2, FIN^3,... We call mad families with respect to the iterated Frechet ideals "higher dimensional" mad families. In this talk, I will try to give an overview of definability and undefinability results for higiher dimensional mad families. This is joint work with David Schrittesser.

SPENCER UNGER, University of Toronto
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 258]
Flows on the torus

In this talk, I'll present some of the contents of two separate joint works about flows. First, joint with Andrew Marks, we produce real valued flows between sets whose boundaries have small box dimension which are simpler than the ones from our Borel circle squaring paper. Second, joint with Anton Bernshteyn and Anush Tserunyan, we produce a whole family of flows with different prescribed combinatorial properties. Further we show that our method applies to a class of functions that includes both differences of characteristic functions of sets with small boundary and Holder continuous functions with mean 0.

ALLISON WANG, Carnegie Mellon University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 258]
Every CBER is smooth below the Carlson-Simpson generic partition

One difficulty that arises in studying the class of countable Borel equivalence relations (CBERs) is that in many cases, the complexity of a CBER lies on a "small" set. For instance, a result of Hjorth and Kechris states that every CBER on a Polish space is hyperfinite when restricted to some comeager set. Another result, due to Mathias, shows that every CBER on the Ellentuck Ramsey space is hyperfinite when restricted to some pure Ellentuck cube. In this talk, we will show that every CBER on the space of all infinite partitions of the natural numbers coincides with equality below a Carlson-Simpson generic element. This is joint work with Aristotelis Panagiotopoulos.

Skills Coaching in the Mathematics Classroom
Entraînement des compétences dans les classes de mathématiques

Org: Tyler Pattenden (King's University College) and/et **Andrew Skelton** (York University)

In many post-secondary mathematics courses, the focus is squarely on mathematical content, but we know there are far more intangible skills a student develops in the mathematics classroom. The aim of this session is to make those intangible skills more tangible.

The Conference Board of Canada's Employability Skills brochure lists 16 skills that are needed to improve ability and thrive in the workplace and beyond. Problem-solving and numeracy, typically the highest priorities in most post-secondary mathematical classrooms, are just two of these 16 skills, so how do we explicitly teach and evaluate progress in other skills ? Studies have shown that focusing simultaneously on mathematical and other academic skills is invaluable in helping students with the high school to university mathematics transition (Lake et al 2017) .

In this session, we want to learn from instructors who have developed tools that help with the explicit, intentional, and targeted teaching and learning of a skill, rather than a mathematical concept. This skill could be, but is certainly not limited to, communication, group work, learning skills, peer evaluation, reflection, goal setting, using multiple representations, or research skills. We are interested in hearing about the development of your tool, any obstacles you faced and how you have or might evaluate the success of your intervention.

Dans de nombreux cours de mathématiques postsecondaires, l'accent est mis sur le contenu mathématique, mais nous savons qu'il existe des compétences beaucoup plus intangibles qu'un étudiant développe en classe de mathématiques. L'objectif de cette session est de rendre ces compétences intangibles plus tangibles.

La brochure du Conference Board du Canada sur les compétences relatives à l'employabilité énumère 16 compétences nécessaires pour améliorer les capacités et s'épanouir sur le lieu de travail et au-delà. La résolution de problèmes et la numératie, qui sont généralement les plus grandes priorités dans la plupart des classes de mathématiques des établissements postsecondaires, ne sont que deux de ces 16 compétences, alors comment enseigner et évaluer explicitement les progrès dans les autres compétences ? Des études ont montré que le fait de se concentrer simultanément sur les compétences mathématiques et d'autres compétences académiques est inestimable pour aider les élèves à faire la transition entre l'école secondaire et l'université en mathématiques (Lake et al 2017) .

Dans cette session, nous voulons apprendre des instructeurs qui ont développé des outils qui aident à l'enseignement et à l'apprentissage d'une compétence, plutôt que d'un concept mathématique, tel que cet objectif est explicite, intentionnel et ciblé. Cette compétence pourrait être, mais n'est certainement pas limitée à, la communication, le travail de groupe, les compétences d'apprentissage, l'évaluation par les pairs, la réflexion, la fixation d'objectifs, l'utilisation de représentations multiples, ou les compétences de recherche. Nous sommes intéressés par le développement de votre outil, les obstacles que vous avez rencontrés et la façon dont vous avez ou pourriez évaluer le succès de votre intervention.

Schedule/Horaire — Room/Salle: STEM 224

Saturday June 3 — samedi 3 juin

8:00 - 8:30	Matthew Cheung (York University), *Designing a Developmental Mathematics Course to Support Productive Struggle* (p. 172)
8:30 - 9:00	Darja Barr (University of Manitoba), *Test Anxiety: Fight or Flight ? !* (p. 172)
9:00 - 9:30	Fabian Parsch (University of Toronto), *Teaching and assessing student writing in two-stage team assignments* (p. 174)
9:30 - 10:00	Diana Skrzydlo (University of Waterloo), *Teaching and Assessing Professional Skills* (p. 175)
10:00 - 10:30	Asmita Sodhi (University of Victoria), *Developing Metacognitive Skills through Guided Reflection* (p. 175)
15:00 - 15:25	Chris Eagle (University of Victoria), *Simulating mathematics research in the classroom* (p. 173)
15:25 - 15:50	Peter Harrington (University of British Columbia), *Group work, reflection, and mathematical communication in a large first year calculus course* (p. 173)
15:50 - 16:15	Burcu Tuncer Karabina (University of Waterloo), *The Whys, Whats, and Hows of Feedback* (p. 174)
16:15 - 16:40	Ana Duff (Ontario Tech University), *Teaching Problem-Solving Using a Systematic Framework* (p. 173)

Skills Coaching in the Mathematics Classroom
Entraînement des compétences dans les classes de mathématiques

16:40 - 17:05	Anton Mosunov (University of Waterloo), *Problem Solving Sessions and Presentation of Proofs In Advanced Algebra Class* (p. 174)
17:05 - 17:30	Jessie Meanwell (McMaster University), *Takeaways from Teacher Desmos: implementing an interactive tool to encourage visual thinking in complex analysis* (p. 174)
17:30 - 17:55	Carmen Bruni (University of Waterloo), *Years in the Making - The Story of CS136L* (p. 172)

Abstracts/Résumés

DARJA BARR, University of Manitoba
[Saturday June 3 / samedi 3 juin, 8:30 – STEM 224]
Test Anxiety: Fight or Flight ?!

As more and more of our students seem to be experiencing significant anxiety during and around test times, we may be asking ourselves if there is anything that we can do. One school of thought suggests minimizing or even eliminating high stakes exams in favour of lower stakes tests and other forms of assessment. Another strategy proposes that there is a place for high stakes examinations in education, and that rather than finding ways of avoiding them, we should be focusing on equipping our students with the skills to face the challenge head-on. This talk will focus on ways to model and hone good test taking practices in the post-secondary mathematics classroom.

CARMEN BRUNI, University of Waterloo
[Saturday June 3 / samedi 3 juin, 17:30 – STEM 224]
Years in the Making - The Story of CS136L

Functioning programmers in the modern day require skills using basic productivity tools such as bash scripting, version control, IDE navigation, testing skills and debugging skills. For nearly twenty years, mathematics students at the University of Waterloo have had this material integrated into courses as content they should know but that instructors would take limited to no class time to cover. Finally, after nearly two decades, the first lab course in the Faculty of Mathematics, CS136L has been approved, created and its first offering delivered. In this talk, we describe the story of how this material was thrown around several different courses, how it eventually found its new home, what is in the course, and some of the grading principles used in the course.

MATTHEW CHEUNG, York University
[Saturday June 3 / samedi 3 juin, 8:00 – STEM 224]
Designing a Developmental Mathematics Course to Support Productive Struggle

Productive struggle can enhance the developmental mathematics classroom. Developmental mathematics is a sequence of required courses for students needing to build their knowledge in mathematics (Boylan, 1999). Calls have been made to reform developmental mathematics courses as over half of U.S. (Fong et al., 2015) and over a third of Canadian students (CSAP/PREC, 2015) fail to move on to their college programs and subsequent careers. Implanted in this "graveyard of dreams and aspirations" (Merseth, 2011, p.32) is instruction that over-relies on content-focused knowledge transmission delivery models (Bailey et al., 2015 ; Grubb et al., 2011), with students only able to call upon memorized rules and procedures (Stigler et al., 2010) while lacking belief that they can succeed in math (Zientek et al., 2019). Productive struggle provides an answer as students are supported in their efforts to understand mathematics that are not immediately apparent (Hiebert and Grouws, 2007 ; Warshauer, 2015). Supporting productive struggle requires instructors to help students consider underlying mathematical principles (Lynch et al., 2018) through collaborative tasks (Murawska, 2018) to guide and scaffold students' thinking through

confusion and errors (NCTM, 2014). In doing so, instructors are required to move away from "remedial pedagogy" (Grubb, 2013, p.13), where teachers emphasize correct answers, rules, and procedures through drill and practice. Well-documented is the impact productive struggle may have on K-12 classrooms, but few (e.g., Bickerstaff and Edgecombe, 2019 ; Edwards and Beattie, 2016) have extended the work into developmental mathematics.

ANA DUFF, Ontario Tech University
[Saturday June 3 / samedi 3 juin, 16:15 – STEM 224]
Teaching Problem-Solving Using a Systematic Framework

Problem-solving is a quintessential skill applicable to every sphere of our lives and is a foundation of teaching mathematics. In this talk we will discuss a pedagogical approach to teaching problem-solving using a problem-solving framework that is universal in nature. The discussion frames the problem-solving process with the focus on the problem's deliverable while addressing the inherent and specific conditions on the deliverable in a systematic way, using the dual principle of eyes-on-the-prize and just-in-time information. The framework proposed (and classroom-tested) acknowledges the importance of many skills in the problem-solving process, including but certainly not limited to literacy, recall, reflection, analysis, and focus. Teaching through this framework actively draws attention to, engages, and thus builds those skills. Mathematics, by its necessity in the art of living and its ubiquity in every education system, provides a perfect opportunity to grow these fundamental life skills through the application of the problem-solving framework we propose.

CHRIS EAGLE, University of Victoria
[Saturday June 3 / samedi 3 juin, 15:00 – STEM 224]
Simulating mathematics research in the classroom

The experience of doing mathematics in a homework or examination setting is very different from the experience of mathematical research, and students transitioning from undergraduate mathematics to a graduate program are often surprised at just how different research is from what they spent most of their time doing as an undergraduate. Undergraduate research experiences can help bridge this transition, but they are not available to all students.

In this session I will share an activity that I have used in upper-level math courses (particularly topology and measure theory, though I believe it adapts fairly easily to other settings) that aims to give students something like a taste of mathematics research within the confines of a course. The activity is designed to help develop research skills (such as clarifying the problem, formulating conjectures, and setting goals) while remaining contained to a relatively short amount of time and being focused on topics from the course at hand. The activity also contributes to developing teamwork skills and includes a significant reflective component.

I will share both my impressions of the results as well as anonymous student feedback. I will be very open to your suggestions for further improvements.

PETER HARRINGTON, University of British Columbia
[Saturday June 3 / samedi 3 juin, 15:25 – STEM 224]
Group work, reflection, and mathematical communication in a large first year calculus course

This past year, the introductory calculus course at UBC was redesigned to primarily emphasize group work, with a secondary emphasis on reflection, and clear mathematical communication. The course was designed so that one of the three contact hours a week was centred around active learning in a smaller class. Students formed persistent groups ; they sat with their groups during class, and completed five challenging written group assignments together. Notably, each group assignment began with a reflection question and the grading rubric included items for clear mathematical communication.

At the end of the course we ran student focus groups and analyzed end of term surveys to determine how students experienced the different components of the course. Here we will present the relevant details of the redesign, the results of the student

focus groups and surveys, and our own reflections on improving the course for next year. In particular, we comment on the challenges of doing this at scale, with over 4000 students.

BURCU TUNCER KARABINA, University of Waterloo
[Saturday June 3 / samedi 3 juin, 15:50 – STEM 224]
The Whys, Whats, and Hows of Feedback

Changing technology is disrupting the educational landscape at an alarming rate. 65 percent of today's students will graduate into jobs that do not yet exist, according to the World Economic Forum. Over 85 percent of the jobs in 2030 have not yet been invented. Hard skills tend to have a shelf life of five years. What effect will this analysis have on modern workplaces ? Is it time to shift our emphasis from raising knowledge workers to raising learning workers ? What are the skills needed as a result ? Soft skills will gain importance. Through mathematics, students are able to acquire and master complex problem-solving, reasoning, analysis, creativity, active learning, critical thinking, and programming skills. According to Forbes (2109), 15 soft skills you need to succeed when entering the workforce are empathy, the ability to influence peers, emotional intelligence, curiosity, positivity, active listening, humility, communication skills, creative problem solving, resilience, observation skills, the ability to contextualize, willingness to ask questions, relationship building, self-awareness. How many of these are part of our math curriculum ? What soft skills can we tap into by changing the way we assess student learning and provide feedback ? This talk will examine the implementation of a peer feedback mechanism in a project-based mathematics course called "Introductory Algebra for Social Sciences." We will also take a look at the history of feedback and look at how different forms of feedback have increasingly become integral to learning theories and designs.

JESSIE MEANWELL, McMaster University
[Saturday June 3 / samedi 3 juin, 17:05 – STEM 224]
Takeaways from Teacher Desmos: implementing an interactive tool to encourage visual thinking in complex analysis

In higher-level mathematics education, there is a need for exploration into pedagogical methods beyond the passive lecture and textbook approaches. I built an interactive activity for students learning complex analysis to encourage using visual representations of complex numbers and their manipulation. The aim of the activity was to help students build a strong visual understanding of the mathematics they were learning and to foster student exploration. In this session, I will share takeaways from the development of the activity (built using Teacher Desmos) as well as the evaluation of its success: via students' feeling of learning, a user experience questionnaire, and test scores. I will also talk about how this activity and its evaluation scale to other skills and topics of mathematics.

ANTON MOSUNOV, University of Waterloo
[Saturday June 3 / samedi 3 juin, 16:40 – STEM 224]
Problem Solving Sessions and Presentation of Proofs In Advanced Algebra Class

In Fall 2022 I taught a first-year Advanced Algebra course aimed at developing students' abilities to read, write and discover proofs. Understanding that collaboration and communication are among the top skills of any practicing mathematician, I organized my lectures so that each class had a group problem solving session, followed by a presentation of solutions to given problems to the entire class. In this talk I intend to outline the details of implementation of this course (semi-flipped classroom model, group assignments using Coq proof assistant, etc), reflect on course components that proved to be most beneficial for student learning, and discuss improvements that could be introduced in the future.

FABIAN PARSCH, University of Toronto
[Saturday June 3 / samedi 3 juin, 9:00 – STEM 224]
Teaching and assessing student writing in two-stage team assignments

Skills Coaching in the Mathematics Classroom
Entraînement des compétences dans les classes de mathématiques

A core learning goal of my applied math courses is improving teamwork and written communication skills. One way that I teach and assess these skills are writing-focussed team assignments. I have used such assignments over the last three years in both online and in-person classes that range from 50 to 900 students. More recently, I expanded these assignments into a two-stage process where students first receive feedback on a draft that allows them to reflect on their writing before making their final submission.

In my talk I will explain what priorities and learning goals influence the design of these assessments, how I ensure that all students in each team contribute to the assignment, what kind of rubric I use so that students can get a high writing score even if they have mathematical mistakes, and how TAs provide individual feedback to students.

Of course, no design is without fault and I will also elaborate on the challenges I am facing in the facilitation of these assignments. Two examples are dealing with tricky team dynamics, as well as effectively communicating to students that good writing is not necessarily about being mathematically correct, but instead much more about understandably verbalizing your thought process.

DIANA SKRZYDLO, University of Waterloo
[Saturday June 3 / samedi 3 juin, 9:30 – STEM 224]
Teaching and Assessing Professional Skills

There are many important life and professional skills that students need, which are often not taught or assessed in statistics and mathematics classrooms. When students enter the workplace, they will be expected to: work in teams and have accountability to their team members ; communicate technical results in writing for various audiences ; design and deliver presentations and field questions ; give and receive meaningful feedback ; and self-reflect on their goals, progress, and achievements.

Educators should provide opportunities for students to develop these skills throughout their undergraduate education. Moreover, I believe these should be integrated with their technical education, not only as a separate course.

This talk will discuss best practices for incorporating professional skills using team projects, reflective writing, and other authentic assessments. Participants will also be invited to share their own practices and will come away with tangible ideas for incorporating these skills into their classrooms and assessments.

ASMITA SODHI, University of Victoria
[Saturday June 3 / samedi 3 juin, 10:00 – STEM 224]
Developing Metacognitive Skills through Guided Reflection

Understanding how one thinks and learns, called metacognition, is an essential part of being an effective student. This is especially important in self-directed learning, where a student has an extra level of independence – but reflecting on one's learning is a skill many students haven't had a chance to practice. Working as both a math instructor and a study skills coach during the 2020-2021 academic year, it was very obvious to me that my students were struggling with their study skills (including metacognition) even more than usual, especially as many of their online courses were taught asynchronously. In this talk I will describe a weekly reflective exercise used in two condensed, asynchronous online courses in 2022, some student feedback on this exercise, and how I might evaluate the use of such a tool in future.

Sophisticated Stories from the High School Classroom
Histoires sophistiquées tirées des classes de l'école secondaire

Org: Chris Suurtamm (University of Ottawa) and/et **Peter Taylor** (Queen's University)

Much has been written about the need to bring more rich, engaging and authentic mathematics into the school classroom. We will invite high school teachers to work with one or two sophisticated math activities in the 2023 winter-spring term, write a report about it—the experience of both teacher and students—and discuss their findings in this session. A collection of suggested problems will be made available to these teachers. We invite faculty and graduate students in mathematics and math education to interact with the teachers and discuss with them the question of what kinds of experience prepare students for success at university. We will be able to give some travel and registration support to any teacher who is interested in presenting or simply attending.

On a beaucoup écrit sur la nécessité d'introduire des mathématiques plus riches, plus attrayantes et plus authentiques dans les classes. Nous inviterons les enseignants du secondaire à travailler avec une ou deux activités mathématiques sophistiquées au cours du trimestre hiver-printemps 2023, à rédiger un rapport à ce sujet - l'expérience de l'enseignant et des élèves - et à discuter de leurs conclusions au cours de cette session. Une collection de problèmes suggérés sera mise à la disposition de ces enseignants. Nous invitons les professeurs et les étudiants diplômés en mathématiques et en enseignement des mathématiques à interagir avec les enseignants et à discuter avec eux de la question de savoir quel type d'expérience prépare les étudiants à réussir à l'université. Nous serons en mesure d'offrir un soutien pour le voyage et l'inscription à tout enseignant qui souhaite présenter un exposé ou simplement assister à la conférence.

Schedule/Horaire — Room/Salle: STEM 224

Sunday June 4	dimanche 4 juin
9:00 - 10:30	Presentations and discussion, *Sophisticated Stories from the High School Classroom* (p. 176)
15:00 - 17:00	Presentations and discussion, *Sophisticated Stories from the High School Classroom* (p. 176)

Abstracts/Résumés

PRESENTATIONS AND DISCUSSION, Queen's University
[Sunday June 4 / dimanche 4 juin, 15:00 – STEM 224]
Sophisticated Stories from the High School Classroom

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PRESENTATIONS AND DISCUSSION, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 9:00 – STEM 224]
Sophisticated Stories from the High School Classroom

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education to interact with the teachers and discuss with them the question of what kinds of experience prepare students for success at university. We will be able to give some travel and registration support to any teacher who is interested in presenting or simply attending.

Special Session in Number Theory in Celebration of the 70th Birthday of Ram Murty
Théorie des nombres : à l'occasion du 70e anniversaire de Ram Murty

Org: Kumar Murty (University of Toronto) and/et **Gary Walsh** (Tutte, Ottawa)

Number Theory in Canada has an extremely strong tradition, and remains so today with several centers of research across the country. The impact of Ram Murty's illustrious career can be felt in Number Theory from coast to coast. In this session, we invite Number Theory colleagues of Ram Murty from across Canada, and nearby states, to speak on their research, and where applicable, its connections to Ram Murty's work.

La théorie des nombres a une tradition extrêmement forte au Canada, et elle le reste aujourd'hui avec plusieurs centres de recherche à travers le pays. L'impact de l'illustre carrière de Ram Murty se fait sentir en théorie des nombres d'un océan à l'autre. Dans cette session, nous invitons les collègues de Ram Murty en théorie des nombres de tout le Canada et des états voisins à parler de leur recherche et, le cas échéant, de ses liens avec le travail de Ram Murty.

Schedule/Horaire **Room/Salle: LMX 221**

Saturday June 3 — samedi 3 juin

8:00 - 8:30	Karl Dilcher (Dalhousie University), *On a result of Koecher concerning Markov-Apéry type formulas for the Riemann zeta function* (p. 180)
8:30 - 9:00	Hector Pasten (PUC Chile) (p. 181)
9:00 - 9:30	Felix Baril Boudreau (University of Lethbridge), *Arithmetic Rank Bounds for Abelian Varieties* (p. 179)
9:30 - 10:00	Brad Rodgers (Queen's), *Distances between zeros of L-functions at small and large scales* (p. 181)
10:00 - 10:30	Siman Wong (UMass-Amherst) (p. 182)
15:00 - 15:30	Hester Graves (Center for Computing Services), *The minimal Euclidean function on* $\mathbb{Z}[i]$ (p. 180)
15:30 - 16:00	Freydoon Shahidi (Purdue University), *Local Langlands Correspondence and the Internal Structure of Arthur Packets* (p. 182)
16:00 - 16:30	Henri Darmon (McGill University), *Green's functions for RM points.* (p. 179)
16:30 - 17:00	Yu-Ru Liu (University of Waterloo), *Equidistribution of Polynomial Sequences in Function Fields* (p. 181)
17:00 - 17:30	Amir Akbary (University of Lethbridge), *Constants for Artin-like problems* (p. 179)
17:30 - 18:00	Abhishek Bharadwaj (Queen's University), *Linear Relations among special values of* L *functions* (p. 179)

Sunday June 4 — dimanche 4 juin

8:00 - 8:30	Cameron Stewart (University of Waterloo), *On prime factors of terms of binary recurrence sequences* (p. 182)
8:30 - 9:00	Matilde Lalin (Université de Montréal), *The distribution of values of cubic* L*-functions at* $s = 1$ (p. 180)
9:00 - 9:30	Steven Miller (Williams College), *Combinatorics in Analyzing* L*-Function Coefficients and Applications to Low-Lying Zeros* (p. 181)
9:30 - 10:00	Kumar Murty (University of Toronto), *Prime divisors of Fourier coefficients of modular forms* (p. 181)
10:00 - 10:30	Michael Bennett (University of British Columbia), *Powerful numbers in arithmetic progression* (p. 179)
15:00 - 15:30	Hershy Kisilevsky (Concordia University), *Non-Zero Central Values of Dirichlet Twists of Elliptic L-Functions* (p. 180)
15:30 - 16:00	Gary Walsh (Tutte Institute & Ottawa), *Curves with high rank using Pell equations and Murty sums* (p. 182)
16:00 - 16:30	Abdellah Sebbar (University of Ottawa), *Modular Differential Equations* (p. 182)
16:30 - 17:00	Ram Murty (Queen's University), *The large sieve revisited* (p. 181)

Abstracts/Résumés

Please note the following room changes:
LMX 221 changed to CRXC 240
LMX 257 changed to CRX C309
LMX 258 changed to CRC 308

Special Session in Number Theory in Celebration of the 70th Birthday of Ram Murty
Théorie des nombres : à l'occasion du 70e anniversaire de Ram Murty

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AMIR AKBARY, University of Lethbridge
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 221]
Constants for Artin-like problems

For an integer $a(\neq 0, \pm 1)$ and a prime $p \nmid a$, the residual index of a mod p, denoted by $i_a(p)$, is the index of the subgroup $\langle a \rangle$ in the multiplicative group $(\mathbb{Z}/p\mathbb{Z})^\times$. The generalized Artin problem asks for establishing an asymptotic formula

$$\sum_{p \leq x} f(i_a(p)) \sim c_{f,a} \mathrm{li}(x),$$

as $x \to \infty$, for suitable arithmetic function $f(n)$, where $c_{f,a}$ is a constant depending on a and f. In 2012, Adam Felix and Ram Murty proved, under the assumption of GRH, a version of the generalized Artin problem, when $f(n)$ satisfies a certain growth condition. We apply the character sums method of Lenstra, Moree, and Stevenhagen to write the constant in the Felix-Murty theorem, when f is multiplicative, as a product indexed over primes times a correction factor. When $f(n)$ is the divisor function $d(n)$, the so-called Titchmarch divisor problem for Kummer fields, we explicitly compute this constant. This is joint work with Milad Fakhari.

MICHAEL BENNETT, University of British Columbia
[Sunday June 4 / dimanche 4 juin, 10:00 – LMX 221]
Powerful numbers in arithmetic progression

I will discuss some recent work on various old problems of Erdos on powerful numbers in arithmetic progression. This is joint work with Prajeet Bajpai and Tsz Ho Chan.

ABHISHEK BHARADWAJ, Queen's University
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 221]
Linear Relations among special values of L functions

In this talk, we discuss some relations among the values of the digamma function. We also characterise periodic functions f whose special values $L(1, f)$ belong to a restricted vector space. A common theme in both cases is that these values are connected to linear forms in logarithms of numbers in a cyclotomic field. This is a joint work with Ram Murty.

FELIX BARIL BOUDREAU, University of Lethbridge
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 221]
Arithmetic Rank Bounds for Abelian Varieties

In his career, Ram Murty worked on the problem of bounding the rank of Abelian varieties over number fields, for example, in his 1995 paper *On the rank of* $J_0(N)(\mathbb{Q})$.

In this talk, we examine the analogous problem over function fields. Let K be a function field with perfect constant field k of arbitrary characteristic $p \geq 0$. We give upper bounds, depending on K, on the rank of the Mordell-Weil group over K of any Abelian variety which has trivial K/k-trace. Our result generalizes in various ways a previous theorem by Jean Gillibert (Université de Toulouse) and Aaron Levin (Michigan State University) on elliptic curves over functions fields of characteristic p different from 2 and 3 and is moreover stated under weaker assumptions. We also explore some consequences of our result. This is a joint work with Jean Gillibert and Aaron Levin.

HENRI DARMON, McGill
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 221]
Green's functions for RM points.

Let τ_1 and τ_2 be real quadratic elements of discriminants D_1 and D_2 ($D_1 \neq D_2$) of the Drinfeld p-adic upper half plane, let τ_j' be the conjugate of τ_j, let $\Gamma_j \subset \mathbf{SL_2}(\mathbb{Z})$ be the stabiliser of τ_j, and let $(\tau_1, \tau_1') \cdot (\tau_2, \tau_2') \in \{-1, 0, 1\}$ be the topological intersection on the Poincare upper half plane of the two hyperbolic geodesics with these endpoints. Let M_n be the set of 2×2 matrices with integer entries with determinant p. Then the quantity

$$G_n(\tau_1, \tau_2) = \left(\prod_{\gamma \in \Gamma_1 \backslash M_n / \Gamma_2} g(\tau_1, \gamma\tau_2)^{(\tau_1, \tau_1') \cdot \gamma(\tau_2, \tau_2')} \right)^{12}, \quad \text{where} \quad g(z_1, z_2) := \frac{(z_1 - z_2)(z_1' - z_2')}{(z_1 - z_1')(z_2 - z_2')}$$

converges to an element of $\mathbb{Q}_p$ as n tends to infinity. When $p = 2, 3, 5, 7$, or 13, this quantity is expected to be algebraic and to belong to the compositum of the narrow Hilbert class fields of $\mathbb{Q}(\sqrt{D_1})$ and $\mathbb{Q}(\sqrt{D_2})$. For other p it is expected to be transcendental in general. I will describe a conceptual framework for understanding these assertion by interpreting $G(\tau_1, \tau_2) := \lim_{n \to \infty} G_n(\tau_1, \tau_2)$ as the value of an (exponential) Green's function at the pair (τ_1, τ_2) of RM points.

This is a report on a piece of an ongoing joint project with Jan Vonk.

KARL DILCHER, Dalhousie University

[Saturday June 3 / samedi 3 juin, 8:00 – LMX 221]

On a result of Koecher concerning Markov-Apéry type formulas for the Riemann zeta function

In 1980 Koecher derived a method for obtaining identities for the Riemann zeta function at odd positive integers, including a classical result for $\zeta(3)$ due to Markov and rediscovered by Apéry. We extend Koecher's method to a very general setting and prove two specific but still rather general results. As applications we obtain infinite classes of identities for alternating Euler sums, further Markov-Apéry type identities, and identities for even powers of π. (Joint work with Christophe Vignat).

HESTER GRAVES, IDA/CCS

[Saturday June 3 / samedi 3 juin, 15:00 – LMX 221]

The minimal Euclidean function on $\mathbb{Z}[i]$

Ram Murty and his school changed the study of Euclidean algorithms in number fields with class number one by finding growth results on sizes of pre-images of functions. Every Euclidean domain R has a minimal Euclidean function ϕ_R. We introduce the first computable minimal Euclidean function for a non-trivial number field, $\phi_{\mathbb{Z}[i]}$.

HERSHY KISILEVSKY, Concordia University

[Sunday June 4 / dimanche 4 juin, 15:00 – LMX 221]

Non-Zero Central Values of Dirichlet Twists of Elliptic L-Functions

Abstract: We consider heuristic predictions for ''small'' non-zero algebraic central values of twists of the L-function of an elliptic curve E/Q by Dirichlet characters. We provide computational evidence for these predictions and some consequences for an analogue of the Brauer-Siegel Theorem in this context.

MATILDE LALIN, Université de Montréal

[Sunday June 4 / dimanche 4 juin, 8:30 – LMX 221]

The distribution of values of cubic L-functions at $s = 1$

We investigate the distribution of values of cubic Dirichlet L-functions at $s = 1$. Following ideas of Granville and Soundararajan, and Dahl and Lamzouri for quadratic L-functions, we model values of $L(1, \chi)$ with the distribution of random Euler products $L(1, \mathbb{X})$ for certain family of random variables $\mathbb{X}(p)$ attached to each prime. We obtain a description of the proportion of $|L(1, \chi)|$ that are larger or that are smaller than a given bound, and yield more light into the Littlewood bounds. Unlike the quadratic case, there is a clear asymmetry between lower and upper bounds for the cubic case.

This is joint work with Pranendu Darbar, Chantal David, and Allysa Lumley.

YU-RU LIU, University of Waterloo
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 221]
Equidistribution of Polynomial Sequences in Function Fields

We prove a function field analog of Weyl's equidistribution theorem of polynomial sequences. Our result covers the case when the degree of the polynomial is greater than or equal to the characteristic of the field, which is a natural barrier when applying the Weyl differencing process to function fields. This is joint work with Thài Hoàng Lê and Trevor D. Wooley.

STEVEN MILLER, Williams College
[Sunday June 4 / dimanche 4 juin, 9:00 – LMX 221]
Combinatorics in Analyzing L-Function Coefficients and Applications to Low-Lying Zeros

Questions on the distribution of coefficients of L-functions can often be reduced to combinatorial questions, where it is not always clear what is the right object to study. I will discuss some earlier joint results with Ram Murty on effective equidistribution of coefficients in elliptic curve families, and discuss how the perspective gained there helped in attacking other problems. These range from extending results for cuspidal newforms to square-free levels and increasing the support of the higher level densities, which lead to the best bounds on vanishing to high order at the central point.

KUMAR MURTY, Fields Institute and University of Toronto
[Sunday June 4 / dimanche 4 juin, 9:30 – LMX 221]
Prime divisors of Fourier coefficients of modular forms

We discuss some old and new results on prime divisors of Fourier coefficients of normalized Hecke eigenforms. Some of the results to be discussed are joint work with Ram Murty. Other collaborators include A.Chow, S. Gun, N. Laptyeva, S. Pujahari and N. Saradha.

RAM MURTY, Queen's University
[Sunday June 4 / dimanche 4 juin, 16:30 – LMX 221]
The large sieve revisited

The large sieve inequality can be viewed as an inequality involving characters of the additive profinite (Prufer) group $\widehat{\mathbb{Z}}$. We will derive a general inequality for arbitrary profinite groups from which the classical large sieve can be deduced as a special case.

HECTOR PASTEN, PUC Chile
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 221]

BRAD RODGERS, Queen's University
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 221]
Distances between zeros of L-functions at small and large scales

In this talk I will review some of what is known about the statistical distribution of distances between zeros of the Riemann zeta-function, both at the smallest scale at which such considerations are sensible and at a substantially larger scale. I hope to also offer some speculations about connections to 'large scale' limit theorems in random matrix theory and discuss a connection

to work of R. Murty and A. Zaharescu. If there is sufficient time I will also discuss more recent work with J. Lagarias regarding what this information can say about the smallest gaps between zeros.

ABDELLAH SEBBAR, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 16:00 – LMX 221]
Modular Differential Equations

We investigate the modular differential equation $y'' + sE_4y = 0$ on the complex upper half-plane, where E_4 is the weight 4 Eisenstein series and s is a complex parameter. This is equivalent to studying the Schwarz differential equation $\{h, \tau\} = 2sE_4$, where the unknown h is a meromorphic function. On the other hand, such a solution h must satisfy $h(\gamma\tau) = \varrho(\gamma)h(\tau)$, for all $\gamma \in \mathrm{SL}_2(\mathbb{Z})$, where ϱ is a $2-$dimensional complex representation of the modular group and the action on both sides is by linear fractional transformations. Moreover, in order for h to be meromorphic or to have logarithmic singularities at the cusps, it is necessary to have $s = \pi^2 r^2$ with r being a rational number. We show that the nature of the solutions depend on whether ϱ is irreducible or not and on whether its image is finite or not. We will present various techniques to solve the above differential equations in their full generality.

FREYDOON SHAHIDI, Purdue University
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 221]
Local Langlands Correspondence and the Internal Structure of Arthur Packets

This is a semi-expository talk in which we discuss the local Langlands correspondence (LLC), progress made on it, its connection with the tempered L-packets conjecture to the effect that every such packet has a generic element, and its enhancement in terms of Arthur packets. We also elaborate on certain global consequences and conclude by discussing Jiang's conjecture which is a generalization of the tempered L-packet conjecture to non-tempered Arthur packets and explain some results on it, jointly obtained with Baiying Liu.

CAMERON STEWART, University of Waterloo
[Sunday June 4 / dimanche 4 juin, 8:00 – LMX 221]
On prime factors of terms of binary recurrence sequences

We shall discuss estimates from below for the greatest prime factor of the n-th term of an integer valued non-degenerate binary recurrence sequence.

GARY WALSH, University of Ottawa
[Sunday June 4 / dimanche 4 juin, 15:30 – LMX 221]
Curves with high rank using Pell equations and Murty sums

Generalizing a result of Brown and Meyers, we will describe a fairly large family of curves whose rank is at least two, along with a subfamily, determined by the solvability of certain Pell equations, with rank at least three, and show how Ram Murty Sums can be used to find many curves in this family of rank eight, and some of even higher rank.

SIMAN WONG, UMass-Amherst
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 221]

Student Research Talks

Org: Alice Lacaze-Masmonteil (Ottawa) and/et **Daniel Zackon** (McGill)

Schedule/Horaire **Room/Salle: LMX 257**

Saturday June 3 **samedi 3 juin**

8:00 - 8:30	Zhen Shuang (Memorial University of Newfoundland), *Weighted p-Laplacian Parabolic Equation and Signal Decomposition* (p. 185)
8:30 - 9:00	Behnoosh Zamanlooy (McMaster), *Strong Data Processing Inequalities for Locally Differentially Private Mechanisms* (p. 186)
9:00 - 9:30	Chengjun Yue (Memorial University of Newfoundland), *Three Diffusion-wave Models with Nonlocal Operators for Image Denoising* (p. 186)
9:30 - 10:00	Ankana Dey (Université de Sherbrooke), *Metacommunity Theory : Adapting for the Human Microbiome* (p. 184)
10:00 - 10:30	Courtney Allen (University of Guelph), *A de novo implementation of the Anaerobic Digestion Model 1 raises questions about computational speed* (p. 183)
15:00 - 15:30	Arian Haghparast (York), *Critical probability for phase transition in a degenerate random environment* (p. 184)
15:30 - 16:00	Diba Heydary (University of Toronto), *Adventures in Geometric Topology: An Introduction to the Mapping Class Group* (p. 184)
16:00 - 16:30	Silas Vriend (McMaster), *On a Free-Endpoint Isoperimetric Problem in* $\mathbb{R}^2$ (p. 185)
16:30 - 17:00	Achintya Raya Polavarapu (University of Alberta), *Stonean representation of sup-completion of a vector lattice* (p. 185)
17:00 - 17:30	Manal Alzahrani (University of Ottawa), *Computing the Faithful Dimension of Certain Classes of* p*-Groups via the Orbit Method* (p. 183)
17:30 - 18:00	Tonatiuh Matos Wiederhold (University of Toronto), *Two-player infinite games on posets* (p. 185)

Abstracts/Résumés

COURTNEY ALLEN, University of Guelph
[Saturday June 3 / samedi 3 juin, 10:00 – LMX 257]
A de novo implementation of the Anaerobic Digestion Model 1 raises questions about computational speed

The Anaerobic Digestion Model 1 is the quasi industry standard for modelling anaerobic digestion. It was conceived as a system of 35 ordinary differential equations (ODEs), but an alternate form was developed to reduce the stiffness of the system and therefore improve computation time. This alternate form is a system of differential algebraic equations (DAEs). The form of ADM1 (ODE vs DAE) is assumed to be the limiting factor when it comes to computation time. However, comparing a *de novo* ODE implementation written in Julia against existing DAE implementations in Python and Java shows that the Julia ODE implementation outperforms the DAE implementations. This result indicates that computational speed depends more on the numerical methods used to solve the system than the form of the system itself.

MANAL ALZAHRANI, University Of Ottawa
[Saturday June 3 / samedi 3 juin, 17:00 – LMX 257]
Computing the Faithful Dimension of Certain Classes of p*-Groups via the Orbit Method*

The *faithful dimension* of a finite group G over $\mathbb{C}$, denoted by $m_{\mathsf{faithful}}(G)$, is defined to be the smallest integer m such that G can be embedded in $GL_m(\mathbb{C})$. We are interested in computing the faithful dimension of a p-group of the form $G_q := \exp(\mathfrak{f}_{n,c} \otimes_{\mathbb{Z}} \mathbb{F}_q)$, where $q = p^f$ and $\mathfrak{f}_{n,c}$ is the free nilpotent $\mathbb{Z}$-Lie algebra of class c on n generators.

In 2019, Bardestani et al. expressed the faithful dimension of G_q as the solution to a rank minimization problem by applying Kirillov's orbit method. This approach is dependent on the concept of the *commutator matrix* associated to the nilpotent $\mathbb{Z}$-Lie algebra. As a result, they were able to compute the faithful dimension for nilpotency classes $c = 2$ and $c = 3$.

Following Bardestani et al. rank minimization method, we obtain the faithful dimension of the free nilpotent $\mathbb{Z}$-Lie algebra of class $c = 4$ on n generators. An explicit description of the commutator matrix is obtained by using the *Hall basis* of the free $\mathbb{Z}$-Lie algebra $\mathfrak{f}_{n,4}$.

We also explore the computation of the faithful dimension for nilpotency class $c = 5$. With the aid of computer-assisted symbolic computations, we obtain an upper bound for $m_{\mathsf{faithful}}(\exp(\mathfrak{f}_{n,5} \otimes_{\mathbb{Z}} \mathbb{F}_q))$ of magnitude $n^5 q^4$.

ANKANA DEY, Université de Sherbrooke
[Saturday June 3 / samedi 3 juin, 9:30 – LMX 257]
Metacommunity Theory : Adapting for the Human Microbiome

The human microbiota is composed of a diversity of bacteria, fungi, protists and viruses and it is dynamic ; it changes based on what we eat, the medication we take or diseases we may have. In this respect, it is interesting to study how microbial species disperse and change across different parts of our body. To approach this problem, we relied on metacommunity theory, which was originally developed to study macroecological systems but which has been suggested to study microbiomes. In our project we proposed to adapt metacommunity theory for the particularity of humans' physiological system by developing a multivariate Lotka-Volterra Competition Diffusion model, which, is also a continuous extension of metacommunity theory. Moreover, we make our mathematical model more realistic by also accounting for migration, i.e. the arrival of new microbial species within the system. The parameters of this new theoretical model are estimated through Bayesian modelling using data from the Human Microbiome Project. In this presentation, the mathematical model and its associated statistical model will be presented, which relied on Markov chain Monte Carlo.

ARIAN HAGHPARAST, York University
[Saturday June 3 / samedi 3 juin, 15:00 – LMX 257]
Critical probability for phase transition in a degenerate random environment

Percolation is a well-studied phenomenon in statistical physics and probability theory, which describes the behavior of fluids, gases, or other substances as they pass through a random environment. The concept of percolation theory has also been extended to other fields, including computer science, network analysis, and ecology. The critical point is a fundamental concept in percolation theory, which refers to the point at which the system undergoes a phase transition from one state to another.

This study explores how an agent behaves in a randomly generated 2D environment. The cells of our grid environment are randomly filled with either $\uparrow$ or $\leftarrow\updownarrow\rightarrow$ arrows which determine the available adjacent cells, and a parameter p controls the frequency of each one. We are interested in simulating the agent's behavior and, more importantly, approximating a value for p that acts as a critical point for our system and causes a significant change in the behavior of the environment. We use computer simulation to investigate and determine the critical probability value

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DIBA HEYDARY, University of Toronto
[Saturday June 3 / samedi 3 juin, 15:30 – LMX 257]
Adventures in Geometric Topology: An Introduction to the Mapping Class Group

The mapping class group is one of the key algebraic invariants of a topological space, and a chief tool for studying the automorphism group of a manifold. Frequently omitted from undergraduate curriculum, mapping class groups are an essential component of geometric topology, and geometric group theory. This will be an expository (and pictorial !) talk introducing

students to these ideas, including their wider role in hyperbolic geometry and the study of moduli spaces. Familiarity with topology at the level of Munkres' "Topology" will be assumed.

ACHINTYA RAYA POLAVARAPU, University of Alberta
[Saturday June 3 / samedi 3 juin, 16:30 – LMX 257]
Stonean representation of sup-completion of a vector lattice

The study of vector lattices and their relationship with stochastic processes has been an active area of research in recent years. The concept of sup-completion is a powerful tool in this field due to its properties of extending the notion of supremum to partially ordered sets that may not have a natural upper bound. In this talk, we will briefly introduce the field of vector lattices and provide a representation of the sup-completion using the Maeda-Ogasawara theorem. This representation will essentially reduce the sup-completion to studying the properties of continuous functions on the Stone space of the vector lattice. Joint work with Vladimir Troitsky.

ZHEN SHUANG, Memorial Univerisity of Newfoundland
[Saturday June 3 / samedi 3 juin, 8:00 – LMX 257]
Weighted p-Laplacian Parabolic Equation and Signal Decomposition

We show the existence of solutions for a new kind of weighted p-Laplacian parabolic equation and its applications in signal processing in which a signal is decomposed into four parts. The presence of solutions is proved by the Faedo-Galerkin method. The spectrum and decomposition of a signal are constructed through numerical methods in Matlab. Fractional order p-Laplacian and fractional order derivatives are expressed explicitly in the introduced model, so it is easy to implement in Matlab.

SILAS VRIEND, McMaster University
[Saturday June 3 / samedi 3 juin, 16:00 – LMX 257]
On a Free-Endpoint Isoperimetric Problem in $\mathbb{R}^2$

Inspired by a mixed planar partitioning problem, we investigate using classical techniques what can be said of the existence, uniqueness, and regularity of minimizers in a certain free-endpoint isoperimetric problem. By restricting to curves which are expressible as graphs of functions, we prove a full existence-uniqueness-regularity result using a convexity technique inspired by work of Talenti. The problem studied here can be interpreted physically as the identification of the equilibrium shape of a sessile liquid drop in half-space (in the absence of gravity). This is a well-studied variational problem whose full resolution requires the use of geometric measure theory, in particular the theory of sets of finite perimeter, but here we use a more direct, classical geometrical approach. We present conjectures on other mixed planar partitioning problems throughout.

TONATIUH MATOS WIEDERHOLD, University of Toronto
[Saturday June 3 / samedi 3 juin, 17:30 – LMX 257]
Two-player infinite games on posets

Fix a subset of reals S. Alice and Bob take turns picking real numbers, with the only restriction that they must pick strictly between the previous two selected reals. Alice wins Baker's Game if she can legally pick an element of S after the game is over. Bob wins if he can prevent this.

If S is countable, then Bob has a winning strategy. (This is a game-theoretic proof that the reals are uncountable.) Matt Baker asked if the converse is true. Recently, Brian and Clontz used elementary submodels to give a positive answer to this question.

In this talk, we will present some variations of Baker's Game and recent contributions. We mainly discuss generalizations for which having winning strategies characterizes interesting properties of the posets on which the game is played. We also mention connections to Banach-Mazur, Hausdorff gaps, the perfect set property, partition problems, and some nice open questions.

This is joint work with Luciano Salvetti.

CHENGJUN YUE, Memorial University of Newfoundland
[Saturday June 3 / samedi 3 juin, 9:00 – LMX 257]
Three Diffusion-wave Models with Nonlocal Operators for Image Denoising

Images are easy to be contaminated by noise, a kind of high-frequency component, in formation, recording, transmission and etc. The process to remove noise from a noisy image, so as to restore the true image is referred to as image denoising. To be precise, we have the model

$$u_0 = u + n,$$

where u_0 is noisy image, u is clear image, and n is the additive noise. Our target is to recover u from u_0.

We study three models for image denoising. Our models are based on the diffusion equation and wave equation. Traditionally, local operators are often applied in PDE-based models. In our study, we exploit the nonlocal operators, Riesz potentials and fractional Laplacian, to our models. The numerical results present an improvement in the denoising effect compared with the heat equation.

BEHNOOSH ZAMANLOOY, McMaster University
[Saturday June 3 / samedi 3 juin, 8:30 – LMX 257]
Strong Data Processing Inequalities for Locally Differentially Private Mechanisms

We investigate the strong data processing inequalities of locally differentially private mechanisms under a specific f-divergence, namely the E_γ-divergence. More specifically, we characterize an upper bound on the E_γ-divergence between $P\mathsf{K}$ and $Q\mathsf{K}$, the output distributions of an ε-LDP mechanism K, in terms of the E_γ-divergence between the corresponding input distributions P and Q. Interestingly, the tightest such upper bound in the binary case turns out to have a non-multiplicative form. We then extend our results to derive a tight upper bound for general f-divergences. As an application of our main findings, we derive a lower bound on the locally private Bayesian estimation risk that is tighter than the available divergence-based bound in the literature.

Theory and Application of Finite Fields
Théorie et applications de corps finis

Org: Daniel Panario, **David Thomson** and/et **Qiang Wang** (Carleton University)

Finite fields provide the foundation for many aspects of secure and robust communications, finite geometries, combinatorial structures, and more. Their applications include coding and information theory, symmetric and asymmetric cryptography, efficient computer arithmetic, constructions of combinatorial structures for RADAR, SONAR, software testing, and so on.

Les corps finis constituent la base de nombreux aspects des communications sécurisées et robustes, des géométries finies, des structures combinatoires, etc. Leurs applications comprennent le codage et la théorie de l'information, la cryptographie symétrique et asymétrique, l'arithmétique efficace des ordinateurs, la construction de structures combinatoires pour le RADAR, le SONAR, les tests de logiciels, etc.

Schedule/Horaire **Room/Salle: CRXC 408**

Sunday June 4 **dimanche 4 juin**

8:00 - 8:30	Farzane Amirzade (Carleton University), *QC-LDPC construction free of small size elementary trapping sets based on multiplicative subgroups of a finite field* (p. 187)
8:30 - 9:00	Alexander Bors (Carleton University), *Wreath products and cascaded feedback shift registers* (p. 187)
9:00 - 9:30	Lauren Rose (Bard College) (p. 189)
9:30 - 10:00	Mark Saaltink (unaffiliated), *An extremal problem in vector spaces over finite fields.* (p. 189)
10:00 - 10:30	Delaram Kahrobaei (City University of New York), *Post-quantum hash functions using $SL_n(F_p)$* (p. 188)
15:00 - 15:30	Ariane Masuda (City University of New York), *On permutation binomials of the form $x^r(x^{q-1}+a)$ over $\mathbb{F}_{q^e}$* (p. 188)
15:30 - 16:00	Hugo Teixeira (Carleton University), *On the functional graph of $f(X) = c(X^{q+1}+aX^2)$ over quadratic extensions of finite fields* (p. 189)
16:00 - 16:30	Xi Xie (HuBei University), *On the Niho type locally-APN power functions and their boomerang spectrum* (p. 189)
16:30 - 17:00	Simon Kuttner (Carleton University), *Applications of the subset sum problem over finite abelian groups* (p. 188)
17:00 - 17:30	Fernando Neranga (College of the Holy Cross), *Reversed Dickson polynomials of the (k+1)-th kind over finite fields* (p. 188)

Abstracts/Résumés

FARZANE AMIRZADE, Carleton University
[Sunday June 4 / dimanche 4 juin, 8:00 – CRXC 408]
QC-LDPC construction free of small size elementary trapping sets based on multiplicative subgroups of a finite field

An algebraic-based quasi-cyclic low-density parity-check (QC-LDPC) code is developed from an exponent matrix whose entries belong to a finite field $\mathbb{F}_q$, where q is a power of a prime. A QC-LDPC code with variable node degree m and check node degree n is an (m, n)-regular QC-LDPC code. The length of the shortest cycle in the Tanner graph is the girth. It is experimentally known that short cycles and other graphical structures of the Tanner graph named as (a, b) elementary trapping set ((a, b)-ETSs) with small size a cause high decoding failure rate.

We propose a new method to construct algebraic-based QC-LDPC codes with girth 6, using multiplicative subgroups of a finite field. Some algebraic-based QC-LDPC code constructions in the literature are special cases of our construction. Then, we provide sufficient conditions to construct $(3, n)$-regular algebraic-based QC-LDPC codes with girth 6 and free of (a, b) ETSs with $a \leq 5$ and $b \leq 2$.

Theory and Application of Finite Fields
Théorie et applications de corps finis

ALEXANDER BORS, Carleton University
[Sunday June 4 / dimanche 4 juin, 8:30 – CRXC 408]
Wreath products and cascaded feedback shift registers

In cryptography, cascade connections are a means of combining multiple feedback shift registers (FSRs) into hopefully more secure stream ciphers. In this talk, we present recent results, obtained in joint work with Maghsoudi and Wang, on the periods of bit sequences produced by cascade connections of two FSRs. We observe that those periods may be viewed as cycle lengths of a certain permutation on vectors that is an element of a so-called imprimitive permutational wreath product (a certain kind of permutation group). This allows us to study periods of cascade connections with algebraic methods, obtaining both an upper bound on the maximum period of a cascade connection and a complete understanding of the periods in the important case of the cascade connection of an n-dimensional De Bruijn sequence into an m-dimensional linear FSR.

DELARAM KAHROBAEI, The City University of New York, QC, GC, University of York (UK)
[Sunday June 4 / dimanche 4 juin, 10:00 – CRXC 408]
Post-quantum hash functions using $SL_n(F_p)$

We define new families of Tillich-Zémor hash functions, using higher dimensional special linear groups over finite fields as platforms. The Cayley graphs of these groups combine fast mixing properties and high girth, which together give rise to good preimage and collision resistance of the corresponding hash functions. We justify the claim that the resulting hash functions are post-quantum secure. Joint work with Corentin Le Coz, Christopher Battarbee, Ramón Flores, Thomas Koberda.

SIMON KUTTNER, Carleton University
[Sunday June 4 / dimanche 4 juin, 16:30 – CRXC 408]
Applications of the subset sum problem over finite abelian groups

Given a finite abelian group G, a finite set D, and a mapping $f : D \to G$, we find the number of r-subsets $S \subseteq D$ where for $b \in G$,

$$\sum_{x \in S} f(x) = b.$$

We obtain simple exact expressions when f is an abelian group homomorphism. When $G = \mathbb{F}_q$, we extend known results when $D \in \{\mathbb{F}_q, \mathbb{F}_q^*\}$ and $f(x) = x^N$, which include quadratic and semiprimitive cases. We count degree n monic polynomials over $\mathbb{F}_q$ with r distinct roots in a set $D \subseteq \mathbb{F}_q$ when the leading terms of degree at least $n - \ell$ are fixed. We obtain new formulas for $\ell = 1$ when D is a multiplicative subgroup of $\mathbb{F}_q^*$, and for $\ell = 2$ when D is an arbitrary subfield of $\mathbb{F}_q$ with q odd.

ARIANE MASUDA, New York City College of Technology, CUNY
[Sunday June 4 / dimanche 4 juin, 15:00 – CRXC 408]
On permutation binomials of the form $x^r(x^{q-1} + a)$ over $\mathbb{F}_{q^e}$

Let $\mathbb{F}_q$ be the finite field of order q. A polynomial $f \in \mathbb{F}_q[x]$ is a permutation polynomial over $\mathbb{F}_q$ if $f(\mathbb{F}_q) = \mathbb{F}_q$. We will present results on permutation binomials of the form $x^r(x^{q-1} + a)$ over $\mathbb{F}_{q^e}$, where $e \geq 2$ and $a \in \mathbb{F}_{q^e}^*$. This is joint work with Ivelisse Rubio and Javier Santiago.

FERNANDO NERANGA, College of the Holy Cross
[Sunday June 4 / dimanche 4 juin, 17:00 – CRXC 408]
Reversed Dickson polynomials of the (k+1)-th kind over finite fields

Let p be a prime and q a power of p. Let $\mathbb{F}_q$ be the finite field with q elements. The concept of the reversed Dickson polynomial $D_n(a,x)$ was first introduced by Xiang-dong Hou, Gary Mullen, James Sellers and Joseph Yucas in 2009 by reversing the roles of the variable and the parameter in the Dickson polynomial $D_n(x,a)$. In 2012, Steven Wang and Joseph Yucas introduced the reversed Dickson polynomials of the $(k+1)$-th kind $D_{n,k}(a,x)$. For $a \in \mathbb{F}_q$, the n-th reversed Dickson polynomial of the $(k+1)$-th kind $D_{n,k}(a,x)$ is defined by

$$D_{n,k}(a,x) = \sum_{i=0}^{\lfloor \frac{n}{2} \rfloor} \frac{n-ki}{n-i} \binom{n-i}{i} (-x)^i a^{n-2i},$$

and $D_{0,k}(a,x) = 2-k$.

I am primarily interested in the question: When is $D_{n,k}(a,x)$ a permutation polynomial of $\mathbb{F}_q$? In this talk, I will explain my recent results on the permutation behavior of reversed Dickson polynomials over finite fields. I will also talk about some general properties of the reversed Dickson polynomials of the $(k+1)$-th kind. These results unify and generalize many previously discovered results on reversed Dickson polynomials over finite fields. Moreover, I will talk about my current research on reversed Dickson polynomials.

LAUREN ROSE, Bard College
[Sunday June 4 / dimanche 4 juin, 9:00 – CRXC 408]

MARK SAALTINK, unaffiliated
[Sunday June 4 / dimanche 4 juin, 9:30 – CRXC 408]
An extremal problem in vector spaces over finite fields.

What is the largest number of bases contained in n points in the r-dimensional vector space over $\mathbb{F}_q$?

In this talk I provide asymptotic results, exact results for some values of n, and upper and lower bounds. Along the way I will introduce an interesting question on uniform hypergraphs, with connections to a theorem of Turán.

This is joint work with Brett Stevens.

HUGO TEIXEIRA, Carleton University
[Sunday June 4 / dimanche 4 juin, 15:30 – CRXC 408]
On the functional graph of $f(X) = c(X^{q+1} + aX^2)$ over quadratic extensions of finite fields

Let $X = \mathbb{F}_q$ be the finite field with q elements and $char(\mathbb{F}_q)$ odd. In this work we discuss the characteristics of the functional graph of the map $X \mapsto c(X^{q+1} + aX^2)$ over the field $\mathbb{F}_{q^2}$, where $c, a \in \mathbb{F}_q$. We observe that this function defines a quadratic form over $\mathbb{F}_q$, therefore it is a natural generalization of the function $x \mapsto cx^2$ over $\mathbb{F}_q$. We give the number of cycles of each length and the precise behavior of the pre-cycles for $a \in \{\pm 1\}$ and some partial results for the other cases. In particular, we describe the connected components that contains the fixed points of f.

XI XIE, Hubei University & Carleton Univeresity
[Sunday June 4 / dimanche 4 juin, 16:00 – CRXC 408]
On the Niho type locally-APN power functions and their boomerang spectrum

In this talk, we focus on the so-called locally-APN power functions introduced by Blondeau, Canteaut and Charpin, which generalize the well-known notion of APN functions and possibly more suitable candidates against differential attacks. Specifically, given two coprime positive integers m and k such that $\gcd(2^m+1, 2^k+1) = 1$, we investigate the locally-APN-ness property of the Niho type power function $F(x) = x^{s(2^m-1)+1}$ over the finite field $\mathbb{F}_{2^{2m}}$ for $s = (2^k+1)^{-1}$, where $(2^k+1)^{-1}$ denotes

the multiplicative inverse modulo 2^m+1. By employing finer studies of the number of solutions of certain equations over finite fields, we prove that $F(x)$ is locally-APN and determine its differential spectrum. We emphasize that computer experiments show that this class of locally-APN power functions covers all Niho type locally-APN power functions for $2 \leq m \leq 10$. In addition, we also determine the boomerang spectrum of $F(x)$ by using its differential spectrum, which particularly generalizes a recent result by Yan, Zhang and Li.

p-adic groups and representations in the Langlands program
Groupes p-adiques et représentations dans le programme de Langlands

Org: Clifton Cunnigham (University of Calgary) and/et **Monica Nevins** (University of Ottawa)

This session welcomes speakers in all aspects of the local and global Langlands correspondence, including representations of p-adic groups, Galois representations, structure theory, characters and the construction of L-, A- and ABV- packets.

Cette session accueille des conférenciers dans tous les aspects de la correspondance locale et globale de Langlands, y compris les représentations des groupes p-adiques, les représentations de Galois, la théorie de la structure, les caractères et la construction de paquets L-, A- et ABV-.

Schedule/Horaire **Room/Salle: STEM 664**

Sunday June 4 **dimanche 4 juin**

15:00 - 15:30	Karol Koziol (CUNY), *Derived K-invariants and the derived Satake transform* (p. 192)
15:30 - 16:00	Kristaps Balodis (Calgary), *p-adic analogs of the Kazhdan-Lusztig hypothesis* (p. 191)
16:00 - 16:30	Siddharth Mahendraker (Boston College) (p. 193)
16:30 - 17:00	Thomas Rüd (MIT), *Stable trace formula, orbital integrals, and Tamagawa numbers* (p. 193)
17:00 - 17:30	Adèle Bourgeois (TIMC), *Functoriality of Supercuspidal L-packets* (p. 191)
17:30 - 18:00	Fiona Murnaghan (Toronto), *Relatively supercuspidal representations* (p. 193)

Monday June 5 **lundi 5 juin**

9:00 - 9:30	E Thompson (Calgary), *A Geometric Algorithm for Computing Zelevinsky Standard Representations.* (p. 193)
9:30 - 10:00	Sarah Dijols (Calgary), *Recent progress on the search for representations of G_2 distinguished by SO_4* (p. 192)
10:00 - 10:30	Melissa Emory (OK State), *Beyond Endoscopy via Poisson Summation* (p. 192)
15:00 - 15:30	José Cruz (Calgary), *Vogan's perspective on the local Langlands Correspondence, the Fourier Transform and the Function Sheaf Dictionary* (p. 192)
15:30 - 16:00	James Steele (Calgary), *Koszul duality patterns in the p-adic local Langlands correspondence* (p. 193)
16:00 - 16:30	Ju-Lee Kim (MIT) (p. 192)

Abstracts/Résumés

KRISTAPS BALODIS, University of Calgary
[Sunday June 4 / dimanche 4 juin, 15:30 – STEM 664]
p-adic analogs of the Kazhdan-Lusztig hypothesis

The Kazhdan-Lusztig hypothesis was originally formulated for complex groups, and then real groups. The proofs of these conjectures culminated in the ATLAS project. Among other things, this first allowed mathematicians to "get a grip" on the mysterious $E8$ group. Since then, various attempts at formulating and proving a p-adic analog have been made, beginning with the work of Zelevinsky in the case of $GL(n)$. Our primary goal will be to state a slight modification of the conjecture due to Vogan, the necessity of which was pointed out, though not corrected in a recent pre-print of Solleveld. We will also make comparisons to the famous *Theorem 8.6.23* of Chriss and Ginzburg, which is often cited as being 'the' p-adic analog of Kazhdan-Lusztig hypothesis.

p-adic groups and representations in the Langlands program
Groupes p-adiques et représentations dans le programme de Langlands

ADÈLE BOURGEOIS, Tutte Institute for Mathematics and Computing
[Sunday June 4 / dimanche 4 juin, 17:00 – STEM 664]
Functoriality of Supercuspidal L-packets

The Local Langlands Correspondence requires L-packets to satisfy a fundamental functorial property. Borel phrases this property entirely in terms of the representations inside the L-packets. Solleveld presents a more precise form of this conjecture involving characters on a dual group.

In this talk, we restrict our attention to L-packets for supercuspidal L-parameters of tame p-adic groups. Such packets were constructed by Kaletha and consist entirely of supercuspidal representations, for which we have explicit descriptions. We show that Kaletha's L-packets satisfy this wanted functorial property. Furthermore, we show that Solleveld's conjecture holds for quasisplit groups when the L-packets come from supercuspidal L-parameters which are regular.

JOSÉ CRUZ, University of Calgary
[Monday June 5 / lundi 5 juin, 15:00 – STEM 664]
Vogan's perspective on the local Langlands Correspondence, the Fourier Transform and the Function Sheaf Dictionary

Let F be a p-adic group, and let G be a connected reductive algebraic group over F. The local Langlands correspondence for G predicts the existence of a partition of the set of equivalence classes of irreducible representations of $G(F)$, into certain finite sets called L-packets, which in turn correspond to equivalence classes of Langlands parameters. Vogan's perspective on the local Langlands correspondence gives a bijection between smooth irreducible representations sharing an infinitesimal parameter and irreducible perverse sheaves on certain moduli space of Langlands parameters.

The main idea of this talk is to show, in the case of SO_5, how we can use the function-sheaf dictionary to compute the Fourier transforms of some of the simple perverse sheaves appearing in the correspondence. One of the main reasons we are interested in these computations is that the Fourier transform on the geometric side seems to correspond to Aubert's involution on the spectral side !

SARAH DIJOLS, U of Calgary
[Monday June 5 / lundi 5 juin, 9:30 – STEM 664]
Recent progress on the search for representations of G_2 distinguished by SO_4

Joint work with Nadir Matringe.

I will explain how Mackey's theory for p-adic groups allows us to identify this type of representations, and a new approach, in progress, where we use the structure of the p-adic octonions and their quaternionic subalgebras to describe the double coset space $P\backslash G_2/SO_4$.

MELISSA EMORY, Oklahoma State University
[Monday June 5 / lundi 5 juin, 10:00 – STEM 664]
Beyond Endoscopy via Poisson Summation

Langlands proposed a strategy called Beyond Endoscopy to prove the principle of functoriality, which is one of the central questions of present day mathematics. A first step was achieved by Ali Altug who worked with the group $GL(2)$ over the rationals. This project generalizes Altug's result to a number field. In this talk we will emphasize some interesting differences between our work and Altug's work. This is joint work with Malors Espinosa-Lara, Debanjana Kundu and Tian An Wong.

JU-LEE KIM, MIT
[Monday June 5 / lundi 5 juin, 16:00 – STEM 664]

p-adic groups and representations in the Langlands program
Groupes p-adiques et représentations dans le programme de Langlands

KAROL KOZIOL, CUNY Baruch College
[Sunday June 4 / dimanche 4 juin, 15:00 – STEM 664]
Derived K-invariants and the derived Satake transform

The classical Satake transform gives an isomorphism between the complex spherical Hecke algebra of a p-adic reductive group G, and the Weyl-invariants of the complex spherical Hecke algebra of a maximal torus of G. This provides a way for understanding the K-invariant vectors in smooth irreducible complex representations of G (where K is a maximal compact subgroup of G), and allows one to construct instances of unramified Langlands correspondences. In this talk, I'll present work in progress with Cédric Pépin in which we attempt to understand the analogous situation with mod p coefficients, and working at the level of the derived category of smooth G-representations.

SIDDHARTH MAHENDRAKER, Boston College
[Sunday June 4 / dimanche 4 juin, 16:00 – STEM 664]

FIONA MURNAGHAN, University of Toronto
[Sunday June 4 / dimanche 4 juin, 17:30 – STEM 664]
Relatively supercuspidal representations

Let (G, H) be a p-adic symmetric pair. (That is, G is a connected reductive p-adic group and H is the group of fixed points of an involution of G that is defined over the field of definition of G.) The H-relatively supercuspidal representations of G are the H-distinguished representations of G having the additional property that their generalized matrix coefficients are compactly supported modulo $H \cdot Z(G)$, where $Z(G)$ is the centre of G. We will discuss a procedure for constructing H-relatively supercuspidal representations. In addition, we will give information about H-relatively supercuspidal representations whose inertial supports are comprised of regular supercuspidal representations ("regular" in the sense of Kaletha).

THOMAS RÜD, MIT
[Sunday June 4 / dimanche 4 juin, 16:30 – STEM 664]
Stable trace formula, orbital integrals, and Tamagawa numbers

Motivated by both the stable trace formula but also recent advances in the computation of explicit mass formulae for Shimura varieties, I will talk about explicit computations of Tamagawa numbers for maximal tori in symplectic groups as well as a descent problem related to orbital integrals.

JAMES STEELE, University of Calgary
[Monday June 5 / lundi 5 juin, 15:30 – STEM 664]
Koszul duality patterns in the p-adic local Langlands correspondence

The p-adic local Langlands correspondence currently posits a relationship between sets of irreducible representations of **Rep**(G), the category of smooth representations of a connected, reductive, p-adic group G, with sets of so-called Langlands parameters. In this talk, we show that the correspondence can be lifted to a Koszul duality between certain full subcategories of **Rep**(G) and categories resulting from a geometerisation of Langlands parameters and describe the Koszul duality between these pairs of Abelian categories, explaining how many characteristics of the local Langlands program can be formalised through this perspective.

p-adic groups and representations in the Langlands program
Groupes p-adiques et représentations dans le programme de Langlands

E THOMPSON, University of Calgary

[Monday June 5 / lundi 5 juin, 9:00 – STEM 664]

A Geometric Algorithm for Computing Zelevinsky Standard Representations.

The p-adic Khazdhan Lusztig Hypothesis (pKLH) can be described as a relation between multiplicities of representation theoretic objects and dimensions of algebro-geometric objects. Explicitly, the pKLH translates between the Grothendieck group change of basis matrix—which sends Zelevinsky standard representations to irreducible representations—and the stalk table for certain intersection cohomology complexes on a moduli space of Langlands parameters. This relation allows for the structure of Zelevinsky standard representations to be parsed using algebro-geometric tools applied to the well-studied moduli spaces of Langlands parameters known as Vogan varieties. In this talk I will sketch an algorithm for computing the stalks of intersection cohomology complexes attached to trivial local systems which are supported on orbit closures in a given Vogan variety. Currently the algorithm is restricted to the case of $\mathrm{GL}_n(F)$ due to the simple perverse sheaves in this case being characterized by these intersection cohomology complexes for trivial local systems. Nonetheless, this algorithm has shown success for certain infinite families of Vogan varieties, which are classified by appropriate infinitesimal parameters. Once computed, the stalks of the intersection cohomology complexes can be translated back into the decompositions of Zelevinsky standard representations in terms of irreducible representations, assuming the pKLH. Throughout the talk I will provide select examples to elucidate the primary ideas and methods used in the algorithm.

Abstracts/Résumés

WEN AI, Memorial University of Newfoundland

MARIAM AL-HAWAJ, University of Toronto

Generalized pseudo-Anosov Maps and Hubbard Trees

The Nielsen-Thurston classification of the mapping classes proved that every orientation preserving homeomorphism of a closed surface, up to isotopy is either periodic, reducible, or pseudo-Anosov. Pseudo-Anosov maps have particularly nice structure because they expand along one foliation by a factor of $\lambda > 1$ and contract along a transversal foliation by a factor of $\frac{1}{\lambda}$. The number λ is called the dilatation of the pseudo-Anosov. Thurston showed that every dilatation λ of a pseudo-Anosov map is an algebraic unit, and conjectured that every algebraic unit λ whose Galois conjugates lie in the annulus $A_\lambda = \{z : \frac{1}{\lambda} < |z| < \lambda\}$ is a dilatation of some pseudo-Anosov on some surface S.

Pseudo-Anosovs have a huge role in Teichmuller theory and geometric topology. The relation between these and complex dynamics has been well studied inspired by Thurston.

In this project, I develop a new connection between the dynamics of quadratic polynomials on the complex plane and the dynamics of homeomorphisms of surfaces. In particular, given a quadratic polynomial, we show that one can construct an extension of it which is generalized pseudo-Anosov homeomorphism. Generalized pseudo-Anosov means the foliations have infinite singularities that accumulate on finitely many points. We determine for which quadratic polynomials such an extension exists. My construction is related to the dynamics on the Hubbard tree which is a forward invariant subset of the filled Julia set that contains the critical orbit.

MANAL ALZAHRANI, University 0f Ottawa

Computing the Faithful Dimension of p-Groups Associated to Free Nilpotent Lie Algebras Over a Finite Field

The *faithful dimension* of a finite group G over $\mathbb{C}$, denoted by $m_{\mathsf{faithful}}(G)$, is defined to be the smallest integer m such that G can be embedded in $GL_m(\mathbb{C})$. We are interested in computing the faithful dimension of a p-group of the form $G_q := \exp(\mathfrak{f}_{n,c} \otimes_{\mathbb{Z}} \mathbb{F}_q)$, where $q = p^f$ and $\mathfrak{f}_{n,c}$ is the free nilpotent $\mathbb{Z}$-Lie algebra of class c on n generators.

In 2019, Bardestani et al. expressed the faithful dimension of G_q as the solution to a rank minimization problem by applying Kirillov's orbit method. This approach is dependent on the concept of the *commutator matrix* associated to the nilpotent $\mathbb{Z}$-Lie algebra. As a result, they were able to compute the faithful dimension for nilpotency classes $c = 2$ and $c = 3$.

Following Bardestani et al. rank minimization method, we obtain the faithful dimension of the free nilpotent $\mathbb{Z}$-Lie algebra of class $c = 4$ on n generators. An explicit description of the commutator matrix is obtained by using the *Hall basis* of the free $\mathbb{Z}$-Lie algebra $\mathfrak{f}_{n,4}$.

We also explore the computation of the faithful dimension for nilpotency class $c = 5$. With the aid of computer-assisted symbolic computations, we obtain an upper bound for $m_{\mathsf{faithful}}(\exp(\mathfrak{f}_{n,5} \otimes_{\mathbb{Z}} \mathbb{F}_q))$ of magnitude $n^5 q^4$.

MIKE CUMMINGS, McMaster University

Gröbner Geometry for Regular Nilpotent Hessenberg Schubert Cells

The full flag variety is the set of sequences of nested vector subspaces where the i^{th} subspace has dimension i. Hessenberg varieties are subvarieties of the full flag variety that satisfy an inclusion relation depending on a choice of a linear operator and a Hessenberg function. In this poster, we focus on the case of a regular nilpotent operator (in Lie type A) and examine the locally defining ideals of the intersection of these Hessenberg varieties with Schubert cells.

We find Gröbner bases for these Hessenberg Schubert cell ideals and exploit their algebraic structure to recover—in Type A—a result of Tymoczko that regular nilpotent Hessenberg varieties are paved by affines. With this in hand, we compute the Hilbert series of these ideals and conclude that they are complete intersections and geometrically vertex decomposable.

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

MATTHEW HOW-CHUN-LUN, McMaster University

Modelling Hair Curls

We examine a model for hair curls as presented by Basile Audoly and Yves Pomeau. The hair is modelled as an elastic rod in 2D, and we apply variational techniques to obtain a second order ODE with two parameters. From there, various techniques are applied to obtain approximate solutions depending on the regimes of the parameters. These correspond to different qualities of hair, such as gravitational compliance and length. One exceptional case which has been used as an example in advanced ODE courses at McMaster is the regime corresponding to compliant hair, where one can draw a correspondence between behaviors of the free end of the hair and motions of the pendulum. This is part of a project that was completed in the summer of 2021 with Mark Bouman under the supervision of Dr. Lia Bronsard.

VOJIN JOVANOVIC, University of Toronto

HAGGAI LIU, Simon Fraser University

Moduli Spaces of Weighted Stable Curves and their Fundamental Groups

The Delingne-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.

MITRA MANSOORI,

YUAN YUAN, East China Normal University

Dynamics of an age-structured HIV model with general nonlinear infection rate

In this paper, the asymptotical behaviour of an age-structured Human Immunodeficiency Virus infection model with general non-linear infection function and logistic proliferation term is studied. Based on the existence of the equilibria and theory of operator semigroups, linearized stability/instability of the disease-free and endemic equilibria is investigated through the distribution of eigenvalues of the linear operator. Then persistence of the solution semiflow of the considered system is studied by showing the existence of a global attractor and the obtained result shows that the solution semi-flow is persistent as long as the basic reproduction number R0 is greater than 1. Moreover, the Hopf bifurcations problem around the endemic equilibrium is also considered for the situation with a specific infection function. Since the system has two different delays, four cases are discussed to investigate the influence of the time delays on the dynamics of system around the endemic equilibrium including

stability and Hopf bifurcations. At last, some numerical examples with concrete parameters are provided to illustrate the obtained results.

XIA ZHAU, Memorial University of Newfoundland

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.

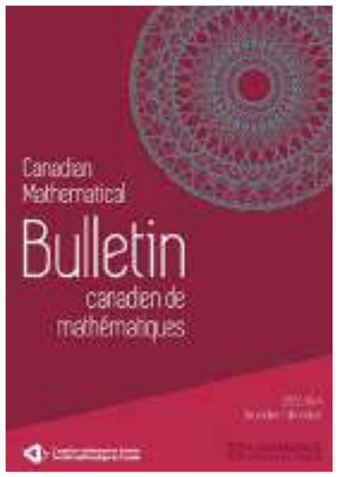
To be submitted to the Journal, papers should be at least 18 pages long and may be written in English or in French. Shorter papers should be submitted to the *Canadian Mathematical Bulletin*.

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

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

Canadian Blood Services

BLOOD
PLASMA
STEM CELLS
ORGANS
& TISSUES

The need for blood and plasma is constant.

Every donation makes a lifesaving difference.

Donate blood or plasma

June 2nd to 5th, Join the
Canadian Mathematical Society

Annual Convention
at the University of Ottawa

We are proudly supporting
Canadian Blood Service

Meet the team and learn about
Plasma & Whole Blood in OTT.

To book an appointment visit **blood.ca**.

Proud partner:

Lincoln,
blood and plasma recipient

Am I eligible to donate plasma?

Let's find out! If you respond "Yes!" to all of the following statements, you may be eligible to donate. Please note that final eligibility is determined by a Canadian Blood Services team member in the donor centre at the time of your appointment. Learn more at **blood.ca/am-i-eligible**

I have not had a piercing or tattoo in the past three months.
If you have, please come back after three months.

I have not travelled outside of Canada, the continental USA, Antarctica or Europe in the last three weeks. Please note that donors who have a history of malaria infection or spent time in a malaria-risk area may donate plasma.

I have not been pregnant or had a baby in the past six months.

I have not had dental extraction, root canal or dental/gum surgery in the past 72 hours.

I am not taking prescription medications.
*(please check acceptable prescription list at **blood.ca/am-i-eligible** or call **1 888 2 DONATE**)*

I have not spent a total of three months or more in the UK between 1980 and 1996, or a total of five years or more in France and/or Ireland between 1980 and 2001.

17+ I am 17 years of age, or older.

I weigh more than 110 lbs.

The plasma donation process

Before you donate...

- Drink plenty of water, eat a healthy meal (avoid fatty foods) and get a good night's sleep
- Bring your government-issued ID or your donor card

At the donor centre...

- Check in with one of our team members
- Complete the donor questionnaire and interview
- If you have not eaten or consumed water, you will be provided with water and a salty snack
- Sit back, relax and donate

After you donate...

- We apply a pressure bandage to your arm
- We ask you to do simple muscle tensing exercises
- We ask you to wait 5 minutes before leaving the centre
- You can grab a snack and a drink before you go. Be sure to rehydrate.

Plasma donors don't just make a difference, they make all the difference.

Canadian Blood Services
BLOOD PLASMA STEM CELLS ORGANS & TISSUES

Orléans Plasma Donor Centre

Place d'Orléans shopping centre
(Beside Marks - exterior entrance only)
110 Place d'Orléans Drive.

Monday 8 a.m. - 2 p.m.
Tuesday - Friday 7 a.m. -7.30 p.m.
Saturday 8 a.m. - 2 p.m.
Sunday Closed
Statutory holidays Closed

Plasma donation

Only the plasma is collected; platelets and red blood cells are returned to the donor.

The donation takes 45 minutes. We ask donors to set aside 90 minutes for the first few donations.

Same eligibility as whole blood (50kg, 145 cm, general good health, etc. No age limit if history of bood donation)

Frequency: Male can donate every 7 days and female every 14 days.

Travel: Donors travelling outside of Canada may donate plasma upon their return.

Malaria: Donors with history of malaria or travelling to malaria-risk area may donate plasma.

What is plasma?

It is a protein-rich yellow liquid; and 55% of blood volume.

Plasma can be used for transfusion or fractionation (aka. source plasma). Plasma collected at the Orléans plasma donor centre is used for fractionation only.

Plasma from Orléans will be manufactured into **50 livesaving medicines** and distributed to **730 hospitals and clinics** across the country.

How to book

- Blood.ca
- GiveBlood app
- 1 888 2 DONATE

The need for plasma is four times more than what is collected in Canada.

Plasma products are helping patients with immune deficiencies, rare blood disorders, cancers, tetanus infections, nervous system disorders, bleeding disorders, kidney and liver diseases, severe burns, surgeries, newborns with Rh disease and many more.

CONTACT: MARIENOELE.COTE@BLOOD.CA

Canadian Mathematical Society
Société mathématique du Canada

UNIVERSITY OF OTTAWA

Username: SSID guOttawa
Password: none required

If you have any issues, please contact Registration

summer23.cms.math.ca

Canadian Mathematical Society
Société mathématique du Canada

2023 CMS Winter Meeting | Montréal, Quebec

CALL FOR *Sessions*

The Canadian Mathematical Society (CMS) welcomes and invites session proposals and mini-course proposals for the 2023 CMS Winter Meeting in Montréal from December 1-4, 2023. 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 December 2-4, 2023.

Deadline: Proposals should be submitted by **Monday, July 31, 2023** to the Scientific Directors and the CMS Office should be cc'ed. There will be a second deadline of **September 1, 2023**, but earlier submissions will be considered first. Their contact information is as follows:

François Bergeron : bergeron.francois@uqam.ca
Simone Brugiapaglia: simone.brugiapaglia@concordia.ca
Alina Stancu: alina.stancu@concordia.ca

Sarah Watson: meetings@cms.math.ca

Canadian Mathematical Society
Société mathématique du Canada

Réunion d'hiver 2023 de la SMC | Montréal, Quebec

NOUS VOUS *Invitons*

La Société mathématique du Canada (SMC) sollicite des propositions de sessions scientifiques et de mini-cours pour sa Réunion d'hiver 2023, qui se tiendra à Montréal du 1 au 4 décembre. 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 2 au 4 décembre 2023.

La date limite pour présenter une proposition de session ou de mini-cours est le **lundi 31 juillet 2023.** Une deuxième date limite sera fixée au **1er septembre 2023**, 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 :

François Bergeron : bergeron.francois@uqam.ca
Simone Brugiapaglia: simone.brugiapaglia@concordia.ca
Alina Stancu: alina.stancu@concordia.ca

Sarah Watson: meetings@cms.math.ca

Call for University Hosts: Winter '25 / Summer '27

The Canadian Mathematical Society (CMS) welcomes and invites host proposals from Canadian Universities for the 2025 CMS Winter Meeting, and the CMS Summer Meetings for 2027.

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 faculty 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

(For summer meetings) 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 these rooms be available during the proposed dates?

(For winter meetings) Do you have a venue in mind for the meeting, is your University available to host the meeting onsite? If not, CMS will find a property outside the university.

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 Meetings typically run from Friday to Monday on the first weekend in June and December but we are open to other possibilities. Summer meetings typically have 250-350 registrants and winter meetings typically 400-600 in larger cities. Please admit your submissions to Sarah Watson (meetings@cms.math.ca).

Canadian Mathematical Society
Société mathématique du Canada

See you next year

SAVE THE DATE

SAUVEGARD EZ LA DATE

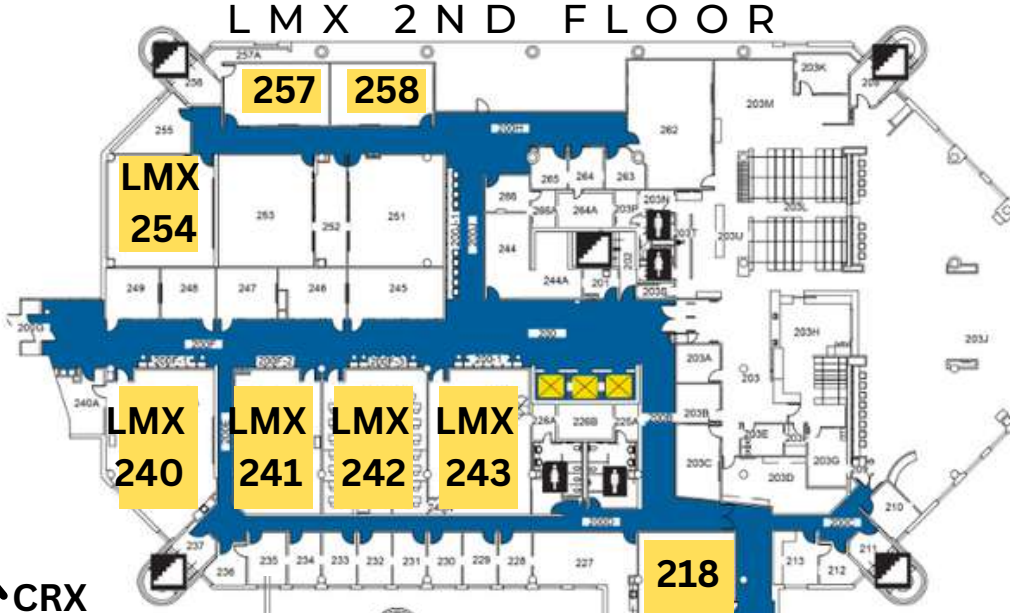
À l'année prochaine

2024 CMS SUMMER MEETING
RÉUNION D'ÉTÉ 2024 DE LA SMC
MAY 31- JUNE 3

SASKATOON, SK

FLOORPLANS

LMX 2ND FLOOR



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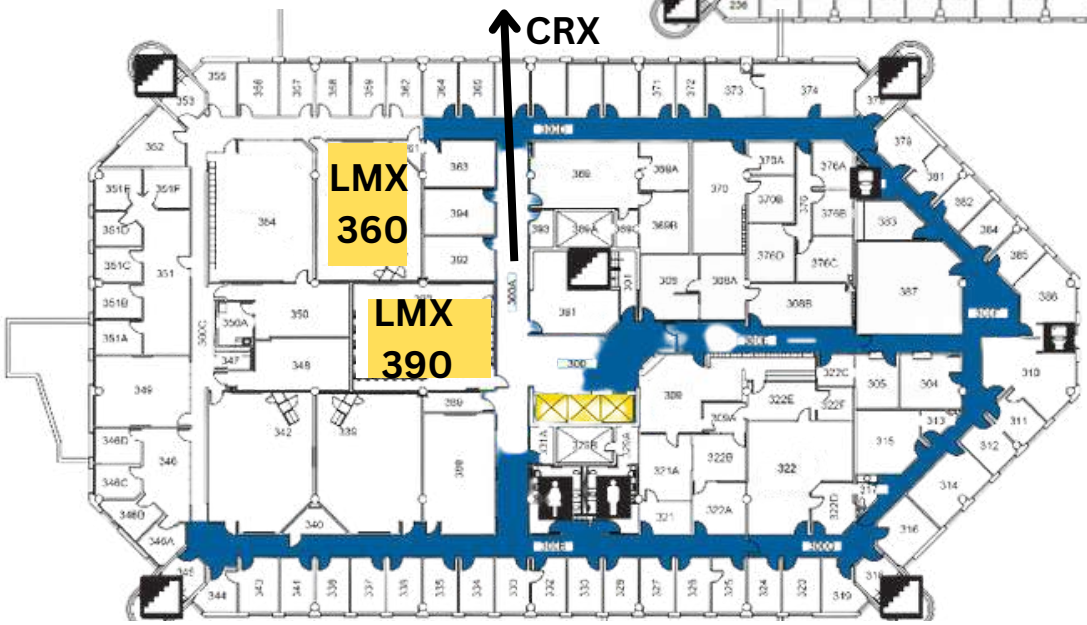

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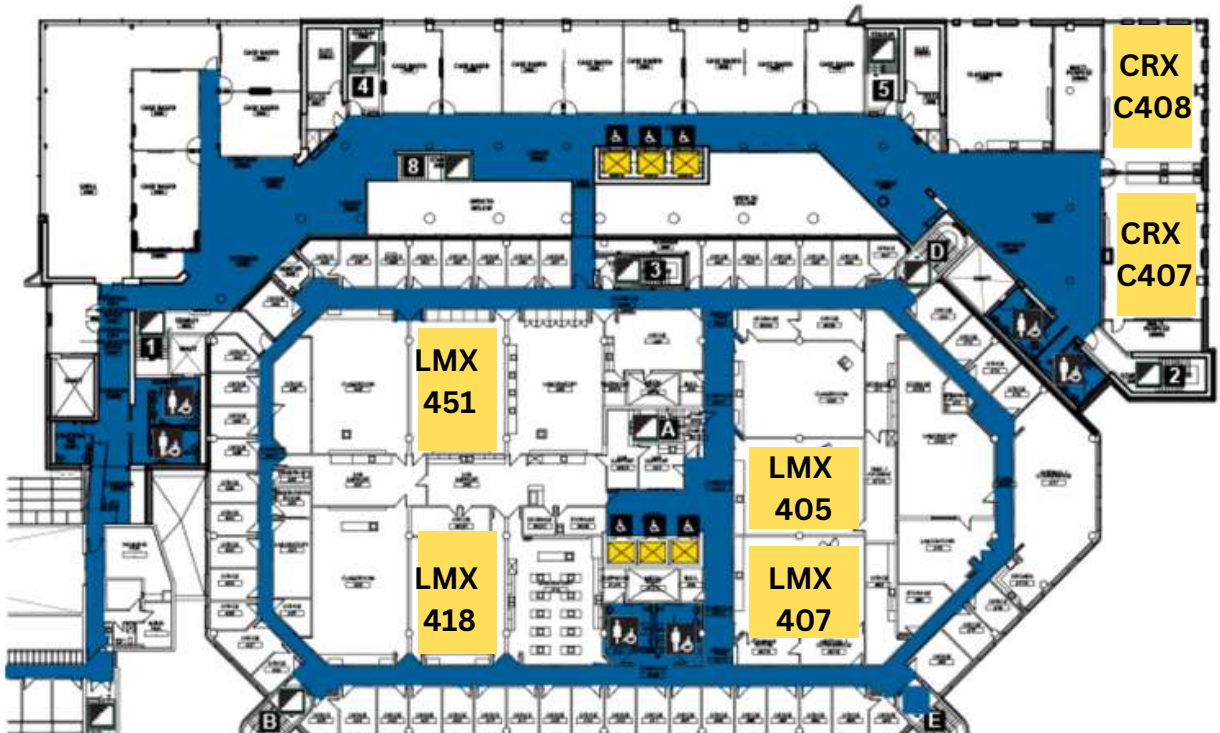

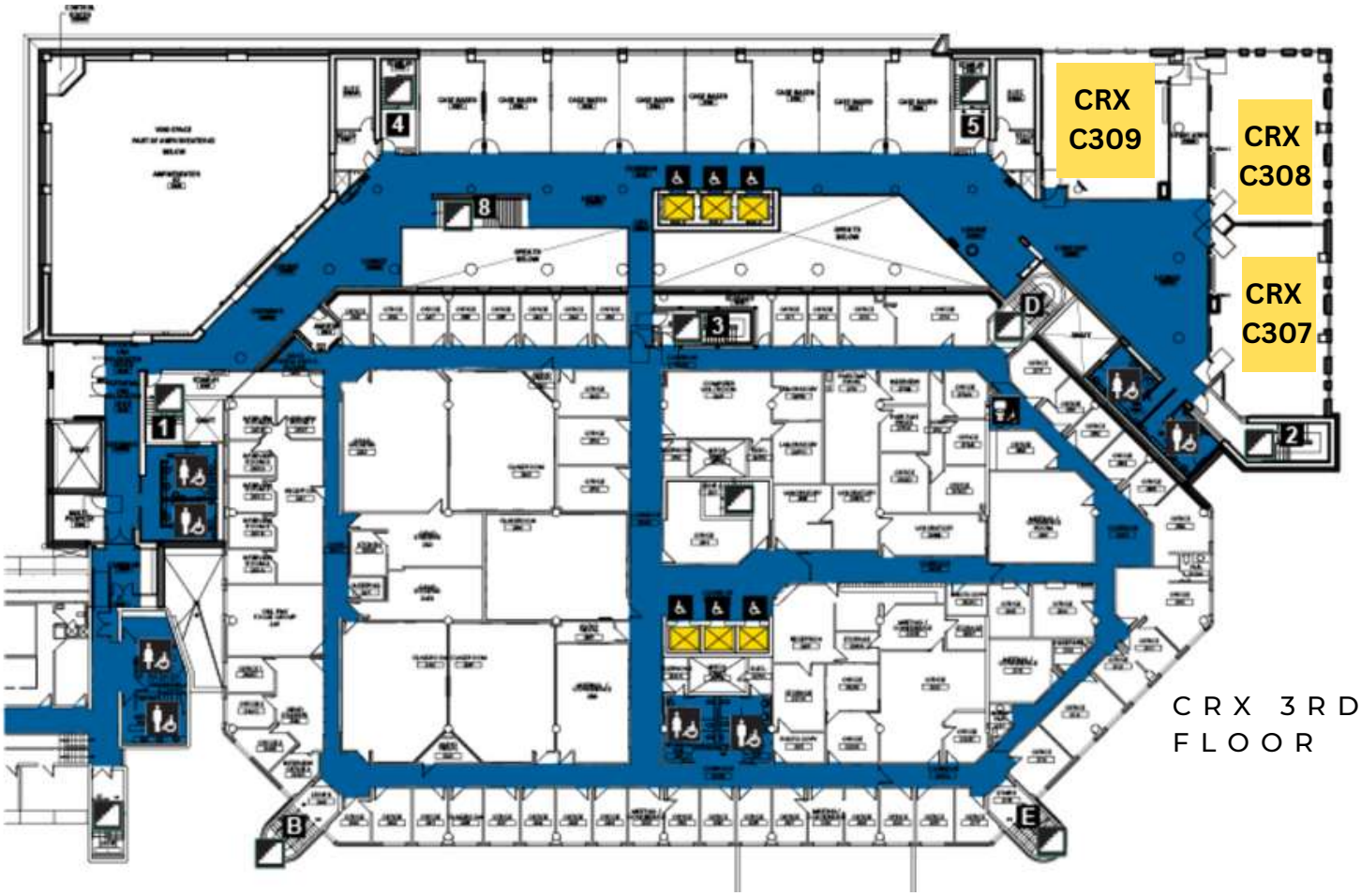

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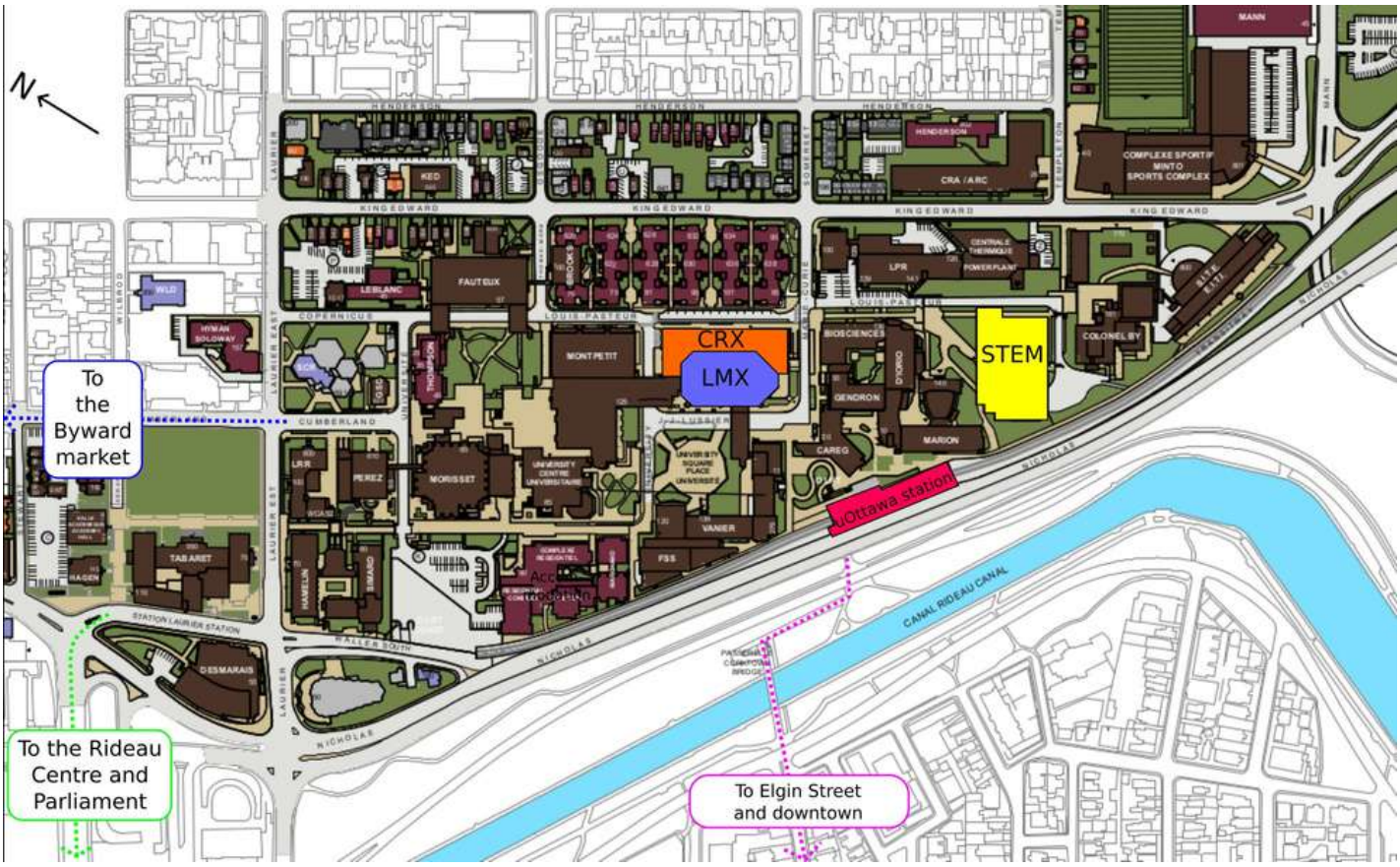
UNIVERSITY OF OTTAWA CAMPUS MAP



FLOORPLANS

STEM 1ST FLOOR

STEM 2ND FLOOR