CMS Summer Meeting
Réunion d'été de la SMC

EDMONTON 2016

June 24-27 • University of Alberta | 24-27 juin • Université de l'Alberta

#CMSSummer16
#EteSMC16

Public Lectures | Conférences publiques

Yuval Peres (Microsoft)

Plenary Lectures | Conférences plénières

Andrea Bertozzi (UCLA) • Andrew Granville (Montreal)
Rachel Kuske (UBC) • Tatiana Shubin (San Jose State Univ.)

Prizes | Prix

Excellence in Teaching Award | Prix d'excellence en enseignement
Krieger-Nelson Prize | Prix Krieger-Nelson

Scientific Directors | Directeurs scientifique

Anthony Quas (Victoria)
Marcelo Laca (Victoria)

Joint reception and plenary lecture with CAIMS at the University of Alberta | Réception et conférence plénière en collaboration avec la SCMAI à l'Université de l'Alberta

Sponsors | Commanditaires

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PIMS
AARMS
UNIVERSITY OF ALBERTA
EDMONTON ORIGINAL

cms.math.ca/Events/summer16

smc.math.ca/Reunions/ete16

Schedule / horaire

Friday | Vendredi June 24 juin	**Saturday | Samedi** June 25 juin	**Sunday | Dimanche** June 26 juin	**Monday | Lundi** June 27 juin
16:00-19:30 - Registration | Inscription *Maple Leaf – Lister Hall*	8:00-17:30 - Registration | Inscription 8:00-17:00 - Poster Session Affiches 9:30-16:00 - Exhibits | Expositions *Maple Leaf – Lister Hall*	8:00-20:00 - Registration | Inscription 8:00-16:00 - Poster Session Affiches 9:30-16:00 - Exhibits | Expositions *Maple Leaf – Lister Hall*	8:00-16:00 - Registration | Inscription *Maple Leaf – Lister Hall*
	8:30 – 10:00 **Scientific Sessions scientifiques**	8:30 – 10:00 **Scientific Sessions scientifiques**	8:30 – 10:00 **Scientific Sessions scientifiques**
	10:00 – 10:30 – Break | Pause	10:00 – 10:30 – Break | Pause	10:00 – 10:30 – Break | Pause
	10:30 – 11:30 Tatiana Shubin **Education Plenary Lecture | Conférence plénière en éducation**	10:30 – 11:30 **Scientific Sessions scientifiques**	10:30 – 11:30 Andrea Bertozzi **Plenary Lecture | Conférence plénière** *Education Building N2 115*
11:00 – 13:00 **CMS Development Group Luncheon | Lunch du Groupe de développement SMC** *Aurora - Lister*	11:30 – 12:30 Ian VanderBurgh **Excellence in Teaching Award Lecture** **Conférence de prix d'excellence en enseignement** *Education Building N2 115*	11:30 – 12:30 Malabika Pramanik **Krieger-Nelson Prize Lecture** **Conférence de prix Krieger-Nelson** *Education Building N2 115*	11:30 – 12:30 Rachel Kuske **Plenary Lecture | Conférence plénière** *Education Building N2 115*
	12:30 – 14:00 ***CMS Annual General Meeting*** ***Assemblée générale annuelle de la SMC*** *(Light lunch provided | Un dîner léger sera fourni)*	12:30 – 14:00 Open break | Pause libre	12:30 – 14:00 Open break | Pause libre
13:00 – 17:00 **CMS Board of Directors Meeting | Réunion du Conseil d'administration SMC** *Aurora - Lister*	14:00 – 15:00 Yuval Peres **Plenary Lecture | Conférence plénière** *Education Building N2 115*	14:00 – 15:00 Andrew Granville **Plenary Lecture | Conférence plénière** *Education Building N2 115*	14:00 – 16:00 **Scientific Sessions scientifiques**
	15:00 – 15:30 – Break | Pause	15:00 – 15:30 – Break | Pause	
16:45 – 17:00 **Opening Address** *Education Building N2 115*	15:30 – 17:30 **Scientific Sessions scientifiques**	15:30 – 17:30 **Scientific Sessions scientifiques**	
17:00 – 18:00 Yuval Peres **Public Lecture | Conférence publique** *Education Building N2 115*	18:30 – 22:00 **Reception and Awards Banquet | Réception et Banquet de prix**	18:00-20:00 **Joint CAIMS/CMS Reception | Réception conjointe SMC/SCMAI** *Maple Leaf – Lister Hall*	
18:00 – 19:30 **Welcome Reception | Réception de Bienvenue** *Wildrose - Lister*			
20:00 – 22:00 **Student Social | Soirée étudiante**			

Sponsors / Commanditaires

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Exhibits, Special Event Sponsorships and Partnerships / Les expositions, les partenariats et le soutien financier des évènements spéciaux

UNIVERSITY OF ALBERTA

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Prizes / Prix

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AlgDes . . . . . Algebraic Design Theory / Théorie de la conception algébrique

AlgGrap . . . . . Algebraic graph theory: including Cayley graphs, group actions on graphs, graph eigenvalues, graphs and matrices / Théorie des graphes algébrique: graphes de Cayley, actions de groupe sur les graphes, valeurs propres d'un graphe, graphes et matrices

AnaNum . . . . . Analytic number theory and Diophantine equations / Analyse et applications d'équations différentielles utilisant des symétries, les lois de la conservation et l'intégrabilité

C&D. . . . . Geo Convex and Discrete Geometry, and Geometric Analysis / Géométrie convexe et discrète, et analyse géométrique

CombGam. . . . . Special Session on Combinatorial Games to celebrate Richard K. Guy's 100th birthday / Session spéciale sur les jeux combinatoires pour célébrer le 100e anniversaire de Richard K. Guy

ComNThe . . . . . Computational Number Theory / Théorie algorithmique des nombres

ContrPa . . . . . Contributed Papers / Communications libres

DiffEqu. . . . . Analysis and applications of differential equations using symmetries, conservation laws, and integrability / Analyse et applications d'équations différentielles utilisant des symétries, les lois de la conservation et l'intégrabilité

ETPriz . . . . . Excellence in Teaching Award / Prix d'excellence en enseignement

GeoMeth. . . . . Geometric Methods in Mechanics and Control with Applications / Méthodes géométriques en mécanique et en contrôle avec applications

IndMath . . . . . Industrial Mathematics / Mathématiques industrielles

KNPriz . . . . . Krieger-Nelson Prize / Prix Krieger-Nelson

MathOut . . . . . Mathematics Outreach Programs: Reach Out, Reach Wide, Reach Deep Programmes de sensibilisation aux mathématiques: promouvoir les maths partout et pour tous

NonlAna . . . . . Theoretical and numerical methods in nonlinear analysis with real-world applications / Méthodes théoriques et numériques en analyse non linéaire avec des applications dans le monde réel

PDE . . . . . Partial Differential Equations / Équations aux dérivées partielles

Plenary . . . . . Plenary Lectures / Conférences plénières
ProjVar . . . . . Rational Points, Rational Curves, and Positivity of Projective Varieties / Points rationnels, courbes rationnelles et positivité des varietés projectives
Public . . . . . Public Lectures / Conférences publiques
RepTheo . . . . . Representation Theory / Théorie des représentations
StuReaP . . . . . Student Research Presentations / Présentations de recherche des étudiants

Session Room Assignments / Allocation des salles

Abbrev.	Regular Sessions | Sessions générales	Room | Salle	Floor
AdLyBio	Advances in Lyapunov Functions in Mathematical Biology |Percées dans les fonctions de Lyapunov en biologie mathématique	Education Building 164	1st Floor
AlgDes	Algebraic Design Theory | Théorie de la conception algébrique	Education Building 221	2nd Floor
AlgGrap	Algebraic graph theory: including Cayley graphs, group actions on graphs, graph eigenvalues, graphs and matrices | Théorie des graphes algébrique: graphes de Cayley, actions de groupe sur les graphes, valeurs propres d'un graphe, graphes et matrices	Education Building 170	1st Floor
DiffEqu	Analysis and applications of differential equations using symmetries, conservation laws, and integrability | Analyse et applications d'équations différentielles utilisant des symétries, les lois de la conservation et l'intégrabilité	Education Building 170	1st Floor
AnaNum	Analytic number theory and Diophantine equations | Analyse et applications d'équations différentielles utilisant des symétries, les lois de la conservation et l'intégrabilité	Education Building 228	2nd Floor
ComNThe	Computational Number Theory | Théorie algorithmique des nombres	Education Building 176	1st Floor
C&DGeo	Convex and Discrete Geometry, and Geometric Analysis | Géométrie convexe et discrète, et analyse géométrique	Education Building 254	2nd Floor
GeoMeth	Geometric Methods in Mechanics and Control with Applications | Méthodes géométriques en mécanique et en contrôle avec applications	Education Building 380	3rd Floor
IndMath	Industrial Mathematics |Mathématiques industrielles	Education Building 377	3rd Floor
MathOut	Mathematics Outreach Programs: Reach Out, Reach Wide, Reach Deep | Programmes de sensibilisation aux mathématiques: promouvoir les maths partout et pour tous	Education Building 303	3rd Floor

PDE	Partial Differential Equations | Équations aux dérivées partielles	Education Building 276	2nd Floor
ProjVar	Rational Points, Rational Curves, and Positivity of Projective Varieties | Points rationnels, courbes rationnelles et positivité des varietés projectives	Education Building 213	2nd Floor
RepTheo	Representation Theory | Théorie des représentations	Education Building 158	1st Floor
CombGam	Special Session on Combinatorial Games to celebrate Richard K. Guy's 100th birthday | Session spéciale sur les jeux combinatoires pour célébrer le 100e anniversaire de Richard K. Guy	Education Building 303	3rd Floor
StuReaP	Student Research Presentations | Présentations de recherche des étudiants	Education Building 206	2nd Floor
NonlAna	Theoretical and numerical methods in nonlinear analysis with real-world applications | Méthodes théoriques et numériques en analyse non linéaire avec des applications dans le monde réel	Education Building 206	2nd Floor
ContrPa	Contributed Papers | Communications libres	Education Building 254	2nd Floor

Welcome to the 2016 CMS Summer Meeting!

Message from Lia Bronsard
President, CMS

Bienvenue à la Réunion d'été 2016 de la SMC !

Message de Lia Bronsard
Présidente, SMC

Welcome to the 2016 CMS Summer Meeting!

It is our great pleasure to welcome you to the 2016 CMS Summer Meeting. This conference, hosted by the University of Alberta, covers a broad variety of topics of great importance to the Canadian mathematical sciences community. There is a tremendous scope for sharing ideas and for us to witness, first hand, the growth and vibrancy of what we have accomplished together. As well, it is an excellent chance to renew collaborations and contacts with colleagues from Canada and abroad.

The program includes five plenary lectures by Yuval Peres (Microsoft), Andrew Granville (Montréal), Andrea Bertozzi (UCLA), Tatiana Shubin (San Jose State University) and Rachel Kuske (UBC) and a public lecture by Yuval Peres (Microsoft).

The meeting also provides an opportunity to celebrate excellence in mathematics by honouring the recipients of the Excellence in Teaching Award – Ian VanderBurgh (Waterloo), and the Krieger-

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Bienvenue à la Réunion d'été 2016 de la SMC!

C'est pour nous un grand plaisir de vous souhaiter la bienvenue à la Réunion d'été 2016 de la SMC. Ce congrès, dont l'hôte est l'Université de l'Alberta, propose un large éventail de sujets d'une grande importance pour la communauté mathématique canadienne. Nul doute qu'il favorisera un foisonnement d'idées et nous permettra de constater, de première main, la croissance et le dynamisme de nos réalisations communes. C'est en outre une occasion sans pareil de réactiver vos collaborations et de renouer avec vos collègues du Canada et d'ailleurs.

Le programme comprend cinq conférences plénières, données par Yuval Peres (Microsoft), Andrew Granville (Montréal), Andrea Bertozzi (UCLA), Tatiana Shubin (San Jose State University) et Rachel Kuske (UBC), ainsi qu'une conférence publique de Yuval Peres (Microsoft).

La Réunion est aussi l'occasion de célébrer l'excellence en mathématiques en honorant le lauréat du Prix d'excellence en enseignement,

Nelson Prize – Malabika Pramanik (UBC). All prizes will be awarded at the awards banquet on Saturday, June 25 at the University of Alberta.

The Summer Meeting's program features 17 sessions with talks relating to all aspects of mathematics, including a mathematics education session and a scientific session organized and delivered entirely by graduate and undergraduate students.

It is my great pleasure to acknowledge the partnership with CAIMS for this meeting. CMS will host a number of joint activities including a joint reception on Sunday evening, a CAIMS/CMS industrial event, and an industrial mathematics session on Sunday and Monday.

Related activities of the meeting will include the CMS Annual General Meeting (AGM) and a documentary screening of Navajo Math Circles by the Education Committee.

We would like to express our gratitude to all sponsors of the Summer Meeting: AARMS, PIMS, Fields, CRM, and Tourism Edmonton.

Anthony Quas and Marcelo Laca (University of Victoria), the Scientific Directors, have worked tirelessly to bring you an attractive and varied program and they deserve our thanks. Such a meeting requires much dedication and drive and would not have been possible without the hard work of the scientific directors, the session organizers, and the CMS staff.

Finally, to all participants, we wish you a very fruitful and enjoyable meeting. Welcome to Edmonton!

Lia Bronsard (McMaster University)
President, CMS

M. Ian VanderBurgh (Waterloo), et la lauréate du prix Krieger-Nelson, Mme Malabika Pramanik (UBC). Ces prix seront remis lors du banquet, qui se déroulera le samedi 25 juin à l'Université de l'Alberta.

Le programme de la Réunion d'été comprend 17 sessions abordant toutes les facettes des mathématiques, dont une session sur l'enseignement des mathématiques et une session scientifique, qui ont été élaborées et seront menées par des étudiants universitaires.

J'ai l'immense plaisir de souligner notre partenariat avec la SCMAI cette année, dans le cadre duquel un certain nombre d'activités conjointes ont été organisées, dont une réception le dimanche soir, une activité industrielle et une session de mathématiques industrielles le dimanche et le lundi.

Parallèlement à la Réunion se tiendront plusieurs activités, comme l'assemblée générale annuelle (AGA) de la SMC, ainsi qu'une projection du documentaire Navajo Math Circles, organisée par le Comité d'éducation.

Nous souhaitons remercier les commanditaires de la Réunion d'été : l'AARMA, le PIMS, l'Institut Fields, le CRM et Tourism Edmonton.

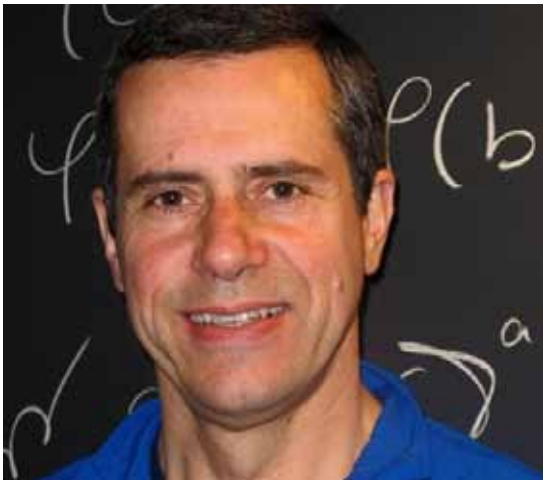
Anthony Quas et Marcelo Laca (Université de Victoria), les directeurs scientifiques, qui ont travaillé d'arrache-pied pour vous offrir un programme attrayant et varié, méritent également nos sincères remerciements. Un événement de cette envergure exige un dévouement et une vigueur sans pareil, et n'aurait jamais vu le jour sans le travail assidu des directeurs de la Réunion, des organisateurs de sessions et surtout du personnel de la SMC.

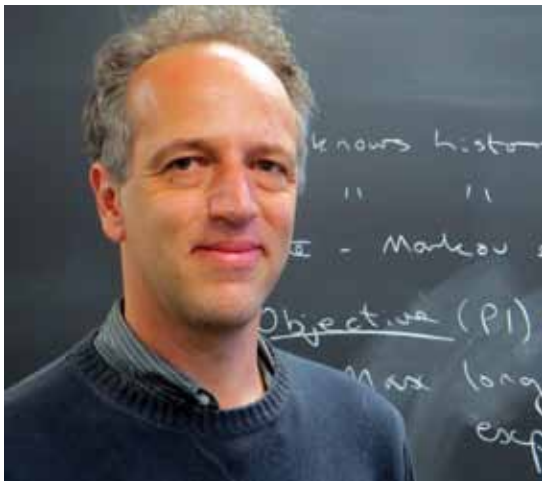
Nous souhaitons à tous les participants un congrès agréable et fructueux. Bienvenue à Edmonton!

Lia Bronsard (Université McMaster)
Présidente, SMC

Welcome Letter from the Scientific Directors

Marcelo Laca (top) and Anthony Quas





Dear Colleague,

On behalf of the Scientific Committee, we would like to take the opportunity to welcome you to the 2016 Summer Meeting of the Canadian Mathematical Society in Edmonton!

We have a very exciting lineup of Plenary lectures: Yuval Peres of Microsoft will kick it off with a public lecture on Friday evening - Yuval will also be giving a Plenary lecture. Our other Plenary speakers are Andrea Bertozzi, Andrew Granville, Rachel Kuske and Tatiana Shubin. In addition, the winners of the CMS Excellence in Teaching Award and the Krieger Nelson Prize will deliver Prize lectures.

For the first time this year, the CMS Summer Meeting is in the same location, and overlapping in time with the CAIMS Summer Meeting. There will be a joint CAIMS/CMS Reception on Sunday night, and there will be an overlapping session on Monday that we hope will be of broad interest - maybe this will give a fascinating glimpse to those of us on the academic side how mathematics is used in an industrial setting.

Mot de bienvenue de le Directeurs scientifique

Marcelo Laca (top) and Anthony Quas

Chers collègues,

Au nom du comité scientifique, nous aimerions vous souhaiter la bienvenue à la Réunion d'été 2016 de la Société mathématique du Canada à Edmonton!

Nous vous avons préparé un programme exceptionnel de conférences plénières : Yuval Peres, de Microsoft, donnera le coup d'envoi vendredi soir avec une conférence publique. Il donnera également une conférence plénière plus tard, tout comme Andrea Bertozzi, Andrew Granville, Rachel Kuske et Tatiana Shubin. De plus, nous aurons droit à la conférence des lauréats du Prix d'excellence en enseignement et du prix Krieger-Nelson.

Pour la première fois cette année, les réunions d'été de la SMC et de la SCMAI se tiendront dans la même ville, au même moment. Nous avons profité de l'occasion pour organiser une réception conjointe le dimanche soir, ainsi qu'une session conjointe le lundi qui, nous l'espérons, saura piquer votre curiosité. Pour ceux d'entre nous qui

Richard Guy, the prolific and inspirational poser of problems in number theory and combinatorial game theory will be turning 100 in September. There will be a special session with distinguished speakers from around the world to honour this milestone. Richard Guy (who lives in Calgary) will join us at the meeting.

We thank the session organizers for their hard work, the speakers in anticipation of their talks, and the Department of Mathematics at the University of Alberta for technical assistance with the meeting.

We're delighted you are here, and hope you have a productive and enjoyable time at the meeting.

Marcelo Laca + Anthony Quas

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sont du côté théorique de la clôture, c'est une belle occasion de découvrir les applications des mathématiques en contexte industriel.

Richard Guy, le prolifique et combien inspirant concepteur de problèmes en théorie des nombres et en théorie des jeux combinatoires, fêtera son 100e anniversaire en septembre. En son honneur, nous organiserons une session spéciale mettant en vedette des conférenciers de renom venus du monde entier. M. Guy, qui habite Calgary, sera des nôtres pendant la Réunion. Nous remercions les organisateurs de sessions pour leur excellent travail, les conférenciers pour leurs présentations qui s'annoncent très stimulantes et le Département de mathématiques de l'Université de l'Alberta pour l'aide technique apportée.

Nous sommes ravis que vous soyez des nôtres, et nous vous souhaitons une Réunion aussi productive qu'agréable.

Marcelo Laca + Anthony Quas

Welcome from Edmonton Economic Development / Mot de bienvenue de Edmonton Economic Development

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EDMONTON ECONOMIC DEVELOPMENT

Delegates,

On behalf of Edmonton Economic Development Corporation (EEDC), the civic agency responsible for Edmonton Tourism, allow me to welcome you to Edmonton for the 2016 Canadian Mathematical Society Meeting.

With over 200 delegates participating in educational sessions, presentations and social events, this year's meeting promises to be a valuable development and networking opportunity for the Canadian Mathematical Society and you as their guests.

Edmonton, with six post-secondary institutions, is home to a wealth of academics, researchers, policy-makers and practitioners, all developing and innovating within the fifth largest city in Canada. This city is the ideal location to capitalize on these local strengths and build partnerships with organizations abroad. With this in mind, I am writing to express EEDC's enthusiasm to host the 2016 Canadian Mathematical Society Meeting and invite you to our city. Education might be the goal of your conference, but it's the experience of the destination that you will talk about for years to come.

We are excited by the opportunity to host you, and we hope you have a chance to experience Edmonton's nature, amenities and attractions during your stay.

Sincerely,

Brad Ferguson
President & CEO

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Schedule for Business Meetings / Horaire pour Séances de travail

Thursday June 23	**jeudi 23 juin**
18:00 - 22:00	CMS Executive Committee / Comité exécutif SMC, Beaver, Chateau Lacombe Hotel

Friday June 24	**vendredi 24 juin**
11:00 - 13:00	CMS Development Group Luncheon / Lunch du Groupe de développement SMC, Aurora, Lister Centre
13:00 - 17:00	CMS Board of Directors Meeting / Réunion du Conseil d'administration SMC, Aurora, Lister Centre
19:30 - 20:30	CMS Education Committee / Comité d'éducation SMC, Prairie Lister Centre

Saturday June 25	**samedi 25 juin**
8:00 - 10:00	CMS Mathematical Competitions Committee / Comité des concours mathématiques SMC, Prairie, Lister Centre
10:30 - 11:30	CMS Student Committee, Evergreen, Lister Centre
12:30 - 14:00	Annual General Meeting / Assemblée générale annuelle, Wild Rose, Lister Centre

Sunday June 26	**dimanche 26 juin**
12:30 - 16:30	CMS Student Committee / Comité des étudiants SMC, Prairie, Lister Centre

Monday June 27	**lundi 27 juin**
14:00 - 16:00	National Advisory Committee of NSERC's Institutes Innovation Platform / National Advisory Committee of NSERC's Institutes Innovation Platform, Evergreen, Lister Centre

Schedule for Related Activities / Horaire pour Activités sociales

Friday June 24	**vendredi 24 juin**
15:00 - 19:30	Registration / Inscription, Maple Leaf - Lister
16:45 - 17:00	Opening Address / Ouverture, Ed N2 115
18:00 - 19:30	Welcome Reception / Réception de Bienvenue, Maple Leaf - Lister
20:00 - 22:00	Student Social / Soirée étudiante

Saturday June 25	**samedi 25 juin**
8:00 - 16:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
8:00 - 17:30	Registration / Inscription, Maple Leaf - Lister
9:30 - 16:00	Exhibits / Expositions, Maple Leaf - Lister
10:00 - 10:30	Break / Pause, Maple Leaf - Lister
10:00 - 10:30	Judging - AARMS-CMS Student Poster Session / Jugement - Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
15:00 - 15:30	Break / Pause, Maple Leaf - Lister
15:00 - 17:00	Judging - AARMS-CMS Student Poster Session / Jugement - Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
18:30 - 22:00	Awards Banquet / Banquet de prix, Wild Rose - Lister

Sunday June 26	**dimanche 26 juin**
8:00 - 16:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
8:00 - 20:00	Registration / Inscription, Maple Leaf - Lister
9:30 - 16:00	Exhibits / Expositions, Maple Leaf - Lister
10:00 - 10:30	Break / Pause, Maple Leaf - Lister
12:30 - 14:00	Open Break / Pause Libre
15:00 - 15:30	Break / Pause, Maple Leaf - Lister
18:00 - 20:00	Joint CAIMS/CMS Reception/Réception conjointe SMC/SCMAI / Joint CAIMS/CMS Reception/Réception conjointe SMC/SCMAI, Maple Leaf - Lister

Monday June 27	**lundi 27 juin**
8:00 - 16:00	Registration / Inscription, Maple Leaf - Lister
10:00 - 10:30	Break / Pause, Maple Leaf - Lister
11:20 - 12:35	CAIMS/CMS Jupyter Workshop / Activité industrielle SCMAI/SMC, CAB Building Room 269
12:30 - 14:00	Open Break / Pause Libre
12:35 - 14:00	CAIMS/CMS Industry Event Panel, CAB Building Room 235
13:30 - 14:30	Joint CMS/CAIMS NSERC Information Session, CAB Building Room 239

Schedule / Horaire

Friday June 24	**vendredi 24 juin**
13:00 - 13:30	Hatef Dastour, StuReaP, Education Building 206
13:30 - 14:00	Raed Mara'Beh, StuReaP, Education Building 206
14:00 - 14:30	Zijia Wang, StuReaP, Education Building 206
15:00 - 19:30	Registration / Inscription, Maple Leaf - Lister
15:00 - 15:30	Aram Dermenjian, StuReaP, Education Building 206
15:30 - 16:00	Chimaobi Amadi, StuReaP, Education Building 206
16:00 - 16:30	Lirong Yang, StuReaP, Education Building 206
16:45 - 17:00	Opening Address / Ouverture, Ed N2 115
17:00 - 18:00	Yuval Peres, Public, Education Building N2 115, *Visual mathematics: From graph partitioning to cellular automata and fair allocation*
18:00 - 19:30	Welcome Reception / Réception de Bienvenue, Maple Leaf - Lister
20:00 - 22:00	Student Social / Soirée étudiante

Saturday June 25	**samedi 25 juin**
8:00 - 16:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
8:00 - 17:30	Registration / Inscription, Maple Leaf - Lister
8:30 - 9:00	Yun Gao, RepTheo, Education Building 158
8:30 - 9:00	Stephen Gustafson, PDE, Education Building 276
8:30 - 9:00	Veselin Jungic, MathOut, Education Building 303
8:30 - 9:00	Matilde Lalin, AnaNum, Education Building 228
8:30 - 9:00	Connell McCluskey, AdLyBio, Education Building 164
8:30 - 9:00	Katherine Stange, ComNThe, Education Building 176
8:30 - 9:00	Jie Xiao, C&DGeo, Education Building 254
8:30 - 9:00	Hiroaki Yoshimura, GeoMeth, Education Building 380
8:30 - 9:15	James Lewis, ProjVar, Education Building 213
9:00 - 9:30	Genevieve Fox, MathOut, Education Building 303
9:00 - 9:30	Mikhail Kotchetov, RepTheo, Education Building 158
9:00 - 9:30	Melvin Leok, GeoMeth, Education Building 380
9:00 - 9:30	Nathan Lindzey, AlgGrap, Education Building 170
9:00 - 9:30	Allysa Lumley, AnaNum, Education Building 228
9:00 - 9:30	Arnaud Marsiglietti, C&DGeo, Education Building 254
9:00 - 9:30	Dimitrios Roxanas, PDE, Education Building 276
9:00 - 9:30	Charles Samuels, ComNThe, Education Building 176
9:00 - 9:30	Jinliang Wang, AdLyBio, Education Building 164
9:15 - 10:00	Dingxin Zhang, ProjVar, Education Building 213
9:30 - 16:00	Exhibits / Expositions, Maple Leaf - Lister

9:30 - 10:00	Melania Alvarez, MathOut, Education Building 303
9:30 - 10:00	Jean-François Biasse, ComNThe, Education Building 176
9:30 - 10:00	Matt Coles, PDE, Education Building 276
9:30 - 10:00	Yoichi Enatsu, AdLyBio, Education Building 164
9:30 - 10:00	Francois Gay-Balmaz, GeoMeth, Education Building 380
9:30 - 10:00	Allen Herman, RepTheo, Education Building 158
9:30 - 10:00	Galyna Livshyts, C&DGeo, Education Building 254
9:30 - 10:00	Greg Martin, AnaNum, Education Building 228
10:00 - 10:30	Break / Pause, Maple Leaf - Lister
10:00 - 10:30	Judging - AARMS-CMS Student Poster Session / Jugement - Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
10:30 - 11:30	Tatiana Shubin, Plenary, Education Building N2 115, *Navajo Math Circles - Lessons Taught and Learned*
11:30 - 12:30	Ian VanderBurgh, ETPriz, Education Building N2 115, *At the intersection of teaching, outreach and education*
14:00 - 15:00	Yuval Peres, Plenary, Education Building N2 115
15:00 - 15:30	Break / Pause, Maple Leaf - Lister
15:00 - 17:00	Judging - AARMS-CMS Student Poster Session / Jugement - Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
15:30 - 16:00	Robert Bailey, AlgGrap, Education Building 170
15:30 - 16:00	Nils Bruin, AnaNum, Education Building 228
15:30 - 16:00	Richard Cushman, GeoMeth, Education Building 380
15:30 - 16:00	Aurore Guillevic, ComNThe, Education Building 176
15:30 - 16:00	Muhammad A. Khan, C&DGeo, Education Building 254
15:30 - 16:00	Monica Nevins, RepTheo, Education Building 158
15:30 - 16:00	Yasuhiro Takeuchi, AdLyBio, Education Building 164
15:30 - 16:00	Xinwei Yu, PDE, Education Building 276
15:30 - 16:15	Roya Beheshti, ProjVar, Education Building 213
15:30 - 16:15	Karol Zyczkowski, AlgDes, Education Building 221
15:30 - 16:30	Navajo Math Circles, MathOut, ED N2 115
16:00 - 16:30	Clifton Cunningham, ComNThe, Education Building 176
16:00 - 16:30	Cathy Kriloff, AlgGrap, Education Building 170
16:00 - 16:30	M. Niksirat, PDE, Education Building 276
16:00 - 16:30	Jedrzej Sniatycki, GeoMeth, Education Building 380
16:00 - 16:30	Haitao Song, AdLyBio, Education Building 164
16:00 - 16:30	Katherine Stange, AnaNum, Education Building 228
16:00 - 16:30	Matthew Stephen, C&DGeo, Education Building 254
16:00 - 16:30	Curtis Wendlandt, RepTheo, Education Building 158
16:15 - 16:45	Rostam Sabeti, AlgDes, Education Building 221
16:15 - 17:00	David McKinnon, ProjVar, Education Building 213
16:30 - 17:00	Alexei Cheviakov, PDE, Education Building 276
16:30 - 17:00	Gerald Cliff, RepTheo, Education Building 158
16:30 - 17:00	Amy Feaver, AnaNum, Education Building 228
16:30 - 17:00	Shonda Gosselin, AlgGrap, Education Building 170
16:30 - 17:00	Jaegil Kim, C&DGeo, Education Building 254
16:30 - 17:00	Vakhtang Putkaradze, GeoMeth, Education Building 380
16:30 - 17:00	Renate Scheidler, ComNThe, Education Building 176
16:30 - 17:00	Pamini Thangarajah, MathOut, ED N2 115
16:30 - 17:00	Yanyu Xiao, AdLyBio, Education Building 164
17:00 - 17:30	Murray Bremner, RepTheo, Education Building 158
17:00 - 17:30	Danielle Cox, Svenja Huntemann, MathOut, ED N2 115
17:00 - 17:30	Joy Morris, AlgGrap, Education Building 170
17:00 - 17:30	James Parks, AnaNum, Education Building 228
17:00 - 17:30	Monireh Rezai Rad, ComNThe, Education Building 176
17:00 - 17:30	Eric Sawyer, PDE, Education Building 276

17:00 - 17:30	Eric Sawyer, PDE, Education Building 276
17:00 - 17:30	Zhisheng Shuai, AdLyBio, Education Building 164
17:00 - 17:30	Ning Zhang, C&DGeo, Education Building 254
18:30 - 22:00	Awards Banquet / Banquet de prix, Wild Rose - Lister

Sunday June 26 — dimanche 26 juin

8:00 - 16:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC, Maple Leaf - Lister
8:00 - 20:00	Registration / Inscription, Maple Leaf - Lister
8:30 - 9:00	Paula Balseiro, GeoMeth, Education Building 380
8:30 - 9:00	Arno Berger, NonlAna, Education Building 206
8:30 - 9:00	Ian Frigaard, IndMath, Education Building 377
8:30 - 9:00	Dimitris Koukoulopoulos, AnaNum, Education Building 228
8:30 - 9:00	Michael Li, AdLyBio, Education Building 164
8:30 - 9:00	Andrew Linshaw, RepTheo, Education Building 158
8:30 - 9:00	Karen Meagher, AlgGrap, Education Building 170
8:30 - 9:00	Richard Nowakowski, CombGam, Education Building 303
8:30 - 9:00	Brendan Pass, PDE, Education Building 276
8:30 - 9:15	Chuck Doran, ProjVar, Education Building 213
9:00 - 9:30	Amir Akbary, AnaNum, Education Building 228
9:00 - 9:30	Jean-Marc Belley, NonlAna, Education Building 206
9:00 - 9:30	Eva Curry, ComNThe, Education Building 176
9:00 - 9:30	Hongbin Guo, AdLyBio, Education Building 164
9:00 - 9:30	Andrew Lewis, GeoMeth, Education Building 380
9:00 - 9:30	Sean McGuinness, AlgGrap, Education Building 170
9:00 - 9:30	Rebecca Milley, CombGam, Education Building 303
9:00 - 9:30	Arian Novruzi, IndMath, Education Building 377
9:00 - 9:30	Jerome Vetois, PDE, Education Building 276
9:00 - 9:30	Deping Ye, C&DGeo, Education Building 254
9:00 - 9:30	Kaiming Zhao, RepTheo, Education Building 158
9:15 - 10:00	Jennifer Park, ProjVar, Education Building 213
9:30 - 16:00	Exhibits / Expositions, Maple Leaf - Lister
9:30 - 10:00	Weiwei Ao, PDE, Education Building 276
9:30 - 10:00	Marlène Frigon, NonlAna, Education Building 206
9:30 - 10:00	Melissa Huggan, CombGam, Education Building 303
9:30 - 10:00	Toshikazu Kuniya, AdLyBio, Education Building 164
9:30 - 10:00	Wenyuan Liao, IndMath, Education Building 377
9:30 - 10:00	Myrto Mavraki, AnaNum, Education Building 228
9:30 - 10:00	Dave Witte Morris, AlgGrap, Education Building 170
9:30 - 10:00	Anton Mosunov, ComNThe, Education Building 176
9:30 - 10:00	Stuart Rogers, GeoMeth, Education Building 380
9:30 - 10:00	Matthew Rupert, RepTheo, Education Building 158
9:30 - 10:00	Konstantin Tikhomirov, C&DGeo, Education Building 254
10:00 - 10:30	Break / Pause, Maple Leaf - Lister
10:30 - 11:00	Aviezri Fraenkel, CombGam, Education Building 303
10:30 - 11:00	Joel Friedman, AlgGrap, Education Building 170
10:30 - 11:00	Vincent X. Genest, RepTheo, Education Building 158
10:30 - 11:00	Mark Gotay, GeoMeth, Education Building 380
10:30 - 11:00	Nathan Grieve, ProjVar, Education Building 213
10:30 - 11:00	Rahma Guen, NonlAna, Education Building 206
10:30 - 11:00	Alia Hamieh, AnaNum, Education Building 228
10:30 - 11:00	Mike Jacobson, ComNThe, Education Building 176
10:30 - 11:00	Paul McNicholas, IndMath, Education Building 377
10:30 - 11:00	Elizaveta Rebrova, C&DGeo, Education Building 254

10:30 - 11:00	Ihsan Topaloglu, PDE, Education Building 276
11:00 - 11:30	Cyril Joël Batkam, NonlAna, Education Building 206
11:00 - 11:30	Xi Chen, ProjVar, Education Building 213
11:00 - 11:30	Danielle Cox, ComNThe, Education Building 176
11:00 - 11:30	Svenja Hunteman, CombGam, Education Building 303
11:00 - 11:30	Peter Cho Ho Lam, AnaNum, Education Building 228
11:00 - 11:30	Adrián Pastine, AlgGrap, Education Building 170
11:00 - 11:30	Yvan Saint-Aubin, RepTheo, Education Building 158
11:00 - 11:30	Shardul Vikram, C&DGeo, Education Building 254
11:00 - 11:30	Eric Woolgar, PDE, Education Building 276
11:00 - 11:30	Dmitry Zenkov, GeoMeth, Education Building 380
11:00 - 11:30	Hongmei Zhu, IndMath, Education Building 377
11:30 - 12:30	Malabika Pramanik, KNPriz, Education Building N2 115, *Configurations in sets big and small*
12:30 - 14:00	Open Break / Pause Libre
14:00 - 15:00	Andrew Granville, Plenary, Education Building N2 115, *The pretentious Riemann Hypothesis and beyond*
15:00 - 15:30	Break / Pause, Maple Leaf - Lister
15:30 - 16:00	Shabnam Akhtari, AnaNum, Education Building 228
15:30 - 16:00	George Bluman, DiffEqu, Education Building 170
15:30 - 16:00	Sean Bohun, IndMath, Education Building 377
15:30 - 16:00	Clifton Cunningham, RepTheo, Education Building 158
15:30 - 16:00	Lucia Moura, AlgDes, Education Building 221
15:30 - 16:00	Paul Ottaway, CombGam, Education Building 303
15:30 - 16:00	George Patrick, GeoMeth, Education Building 380
15:30 - 16:00	Cristian Rios, PDE, Education Building 276
15:30 - 16:00	Abdellatif Serghini, NonlAna, Education Building 206
15:30 - 16:00	Yuriy Zinchenko, C&DGeo, Education Building 254
16:00 - 16:30	Alexei Cheviakov, DiffEqu, Education Building 170
16:00 - 16:30	Gerda de Vries, NonlAna, Education Building 206
16:00 - 16:30	Florin Diacu, GeoMeth, Education Building 380
16:00 - 16:30	Oscar Lopez, IndMath, Education Building 377
16:00 - 16:30	Sergii Myroshnychenko, C&DGeo, Education Building 254
16:00 - 16:30	Chunhua Ou, PDE, Education Building 276
16:00 - 16:30	Luc Vinet, RepTheo, Education Building 158
16:00 - 16:30	Steve Wang, AlgDes, Education Building 221
16:30 - 17:00	Larry Bates, GeoMeth, Education Building 380
16:30 - 17:00	Theodore Kolokolnikov, PDE, Education Building 276
16:30 - 17:00	Athena Nguyen, RepTheo, Education Building 158
16:30 - 17:00	David Pike, AlgDes, Education Building 221
16:30 - 17:00	Dmitry Pshenitsin, DiffEqu, Education Building 170
16:30 - 17:00	Samuel Reid, C&DGeo, Education Building 254
16:30 - 17:00	Gary Walsh, AnaNum, Education Building 228
16:30 - 17:00	Juncheng Wei, NonlAna, Educaiton Building 206
17:00 - 17:30	Dario Brooks, C&DGeo, Education Building 254
17:00 - 17:30	Karl Dilcher, AnaNum, Education Building 228
17:00 - 17:30	Michael Lau, RepTheo, Education Building 158
17:00 - 17:30	Asiyeh Sanaei, AlgDes, Education Building 221
18:00 - 20:00	Joint CAIMS/CMS Reception/Réception conjointe SMC/SCMAI / Joint CAIMS/CMS Reception/Réception conjointe SMC/SCMAI, Maple Leaf - Lister

Monday June 27 — lundi 27 juin

8:00 - 16:00	Registration / Inscription, Maple Leaf - Lister
8:30 - 9:00	Karoly Bezdek, C&DGeo, Education Building 254
8:30 - 9:00	Matt Davison, IndMath, Education Building 377
8:30 - 9:00	Alexander Odesski, DiffEqu, Education Building 170

8:30 - 9:00	Sho Suda, AlgDes, Education Building 221
9:00 - 9:30	Ferenc SZÖLLŐSI, AlgDes, Education Building 221
9:00 - 9:30	Kateryna Tatarko, C&DGeo, Education Building 254
9:00 - 9:30	Anthony Ware, IndMath, Education Building 377
9:00 - 9:30	Thomas Wolf, DiffEqu, Education Building 170
9:30 - 10:00	Ivan Iurchenko, C&DGeo, Education Building 254
9:30 - 10:00	Will Orrick, AlgDes, Education Building 221
9:30 - 10:00	Vahktang Poutkaradze, IndMath, Education Building 377
9:30 - 10:00	Andy Wan, DiffEqu, Education Building 170
10:00 - 10:30	Break / Pause, Maple Leaf - Lister
10:30 - 11:30	Andrea Bertozzi, Plenary, Education Building N2 115
11:20 - 12:35	CAIMS/CMS Jupyter Workshop / Activité industrielle SCMAI/SMC, CAB Building Room 269
11:30 - 12:30	Rachel Kuske, Plenary, Education Building N2 115, *Interactions of noise and non-smooth dynamics: transitions and qualitative changes*
12:30 - 14:00	Open Break / Pause Libre
12:35 - 14:00	CAIMS/CMS Industry Event Panel, CAB Building Room 235
13:30 - 14:30	Joint CMS/CAIMS NSERC Information Session, CAB Building Room 239
14:00 - 14:30	Stephen Anco, DiffEqu, Education Building 170
14:00 - 14:30	Brett Stevens, AlgDes, Education Building 221
14:30 - 15:00	Rob Craigen, AlgDes, Education Building 221
14:30 - 15:00	Elena Recio, DiffEqu, Education Building 170
15:00 - 15:30	Bill Martin, AlgDes, Education Building 221

Notes

Plenary Lectures / Conférences plénières

Schedule/Horaire **Room/Salle: Education Building N2 115**

Saturday June 25	**samedi 25 juin**
10:30 - 11:30	Tatiana Shubin, *Navajo Math Circles - Lessons Taught and Learned*
14:00 - 15:00	Yuval Peres

Sunday June 26	**dimanche 26 juin**
14:00 - 15:00	Andrew Granville, *The pretentious Riemann Hypothesis and beyond*

Monday June 27	**lundi 27 juin**
10:30 - 11:30	Andrea Bertozzi
11:30 - 12:30	Rachel Kuske, *Interactions of noise and non-smooth dynamics: transitions and qualitative changes*

Abstracts/Résumés

ANDREA BERTOZZI, UCLA
[Monday June 27 / lundi 27 juin, 10:30 – Education Building N2 115]

ANDREW GRANVILLE, University de Montreal and University College, London
[Sunday June 26 / dimanche 26 juin, 14:00 – Education Building N2 115]
The pretentious Riemann Hypothesis and beyond

We give some insights into the "alternative approach" to analytic number theory being developed by Soundararajan and the speaker. For example we will motivate the original approach of Riemann to counting primes, and then, using simple ideas from a first complex analysis course, state a version of the Riemann Hypothesis that does not involve zeros of the Riemann zeta function, nor its analytic continuation. We discuss some aspects of the new approach, some of the most exciting recent developments, and the key role it has played in the recent resolution of the Erdos discrepancy problem.

RACHEL KUSKE, University of British Columbia
[Monday June 27 / lundi 27 juin, 11:30 – Education Building N2 115]
Interactions of noise and non-smooth dynamics: transitions and qualitative changes

While there have been recent advances for analyzing the complex deterministic behavior of systems with discontinuous dynamics, there are many open questions about understanding and predicting noise-driven and noise-sensitive phenomena in the non-smooth context. Stochastic effects can often change the picture dramatically, particularly if multiple time scales are present. We

demonstrate novel approaches for exploring and explaining surprising phenomena driven by the interplay of nonlinearities and randomness in specific applications with piecewise smooth dynamics - network excitability, relay control, impacting dynamics, and conceptual climate models. Effective techniques typically depend on the combination of mathematical techniques, multiple scales approximations, and phenomenological intuition from seemingly unrelated canonical models of biophysics, mechanics, and chemical dynamics. The appropriate strategy is not always immediately obvious from the area of application or model type. This gap may follow from the limited attention that stochastic models with discontinuous dynamics have received in the past, or it may be the reason for this limited attention. Combining the geometrical perspective with asymptotic approaches in physical and phase space appears to be a critical part of developing effective approaches.

YUVAL PERES, Microsoft
[Saturday June 25 / samedi 25 juin, 14:00 – Education Building N2 115]

TATIANA SHUBIN, San Jose State University
[Saturday June 25 / samedi 25 juin, 10:30 – Education Building N2 115]
Navajo Math Circles - Lessons Taught and Learned

The goal of the project has always been to bring the spirit of mathematics to the Navajo Nation and to spark interest and joy in problem solving in the students and teachers who participate. In its five years of existence, NNMC has grown in size and complexity; last year alone it connected nearly 2000 students and 250 teachers on the Navajo Nation with more than 40 working mathematicians and scientists from across the United States. We hope the project will develop into a model that may be used to help other under-served populations. In the talk we will discuss seven interrelated components of the project, its implementation and outcomes; we will also share some interesting mathematical ideas.

Prize Lectures / Conférence des lauréats

Schedule/Horaire **Room/Salle: Education Building N2 115**

Saturday June 25 **samedi 25 juin**

11:30 - 12:30 Ian VanderBurgh, *At the intersection of teaching, outreach and education*

Sunday June 26 **dimanche 26 juin**

11:30 - 12:30 Malabika Pramanik, *Configurations in sets big and small*

Abstracts/Résumés

Excellence in Teaching Award
Prix d'excellence en enseignement

IAN VANDERBURGH, University of Waterloo
[Saturday June 25 / samedi 25 juin, 11:30 – Education Building N2 115]
At the intersection of teaching, outreach and education

In this talk, I will share reflections on the work that I am so blessed in which to be involved. I will focus particularly on the outreach that the Centre for Education in Mathematics and Computing (CEMC) does, both in visiting schools to work with students and in teaching teachers through problem solving workshops and our online Master of Mathematics for Teachers program. We will of course look at a handful of interesting problems that seem to engage both students and teachers.

Krieger-Nelson Prize
Prix Krieger-Nelson

MALABIKA PRAMANIK, University of British Columbia, Vancouver
[Sunday June 26 / dimanche 26 juin, 11:30 – Education Building N2 115]
Configurations in sets big and small

When does a given set contain a copy of your favourite pattern (for example, specially arranged points on a line or a spiral, or the vertices of a polyhedron)? Does the answer depend on how thin the set is in some quantifiable sense? Problems involving identification of prescribed configurations under varying interpretations of size have been vigorously pursued both in the discrete and continuous setting, often with spectacular results that run contrary to intuition. Yet many deceptively simple questions remain open. I will survey the literature in this area, emphasizing some of the landmark results that focus on different aspects of the problem.

Public Lectures / Conférences publiques

Schedule/Horaire **Room/Salle: Education Building N2 115**

Friday June 24 **vendredi 24 juin**

17:00 - 18:00 Yuval Peres, *Visual mathematics: From graph partitioning to cellular automata and fair allocation*

Abstract/Résumé

YUVAL PERES, Microsoft

[Friday June 24 / vendredi 24 juin, 17:00 – Education Building N2 115]

Visual mathematics: From graph partitioning to cellular automata and fair allocation

I will survey, and present some striking pictures, of several mathematical models where visualization has played a key role. How can we find the "community" of an individual in a large network, e.g. a social network or the whole web? This is useful when such networks are stored on multiple computers. How can simple rules (such as the celebrated "abelian sandpile), when iterated, create intricate patterns? What is responsible for scaling behavior in these patterns, in the same way a baby resembles an adult? Finally, we will see the beautiful patterns that arise when we attempt to divide a large area fairly between many people in a decentralized manner.

Advances in Lyapunov Functions in Mathematical Biology / Percées dans les fonctions de Lyapunov en biologie mathématique

Org: Hongbin Guo (Ottawa) and/et **Connell McCluskey** (Wilfred Laurier)

Schedule/Horaire **Room/Salle: Education Building 164**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Connell McCluskey, *Lyapunov functionals for delay equations with vector borne transmission*
9:00 - 9:30	Jinliang Wang, *Dynamics of a PDE viral infection model incorporating cell-to-cell transmission*
9:30 - 10:00	Yoichi Enatsu, *Effect of waning immunity on asymptotic behavior of epidemic models*
15:30 - 16:00	Yasuhiro Takeuchi, *Maturation delay for the predators can enhance stable coexistence in prey-predator model with Allee effect*
16:00 - 16:30	Haitao Song, *Global dynamics of two heterogeneous SIR models with nonlinear incidence rate and delays*
16:30 - 17:00	Yanyu Xiao, *Application of Lyapunov Functions to some vector-borne disease models*
17:00 - 17:30	Zhisheng Shuai, *Applications of the graph-theoretic approach to heterogeneous cholera models*

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Michael Li, *Global Stability Problems in Heterogeneous Models for Vector-Borne Diseases*
9:00 - 9:30	Hongbin Guo, *Global stability of stage-structured epidemic models*
9:30 - 10:00	Toshikazu Kuniya, *Global stability analysis for an age-structured multi-group SIR epidemic model*

Abstracts/Résumés

YOICHI ENATSU, Tokyo University of Science
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 164]
Effect of waning immunity on asymptotic behavior of epidemic models

Asymptotic behavior of the positive solutions of epidemic models have been widely studied. Waning immunity of recovered individuals has now been highlighted as an important concept of the modelling for the disease prevalence in the population. In this talk, recent works on the asymptotic stability of equilibria of the model governed by a class of nonlinear delay differential equations, are presented. Incorporating two constant delays that represent latency time and infectious period, a several open problems will also be referred concerning the effect of the loss of immunity on the stability of an endemic equilibrium of the model, via the linearization at the equilibrium when the basic reproduction number is greater than 1.

HONGBIN GUO, University of Ottawa
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 164]
Global stability of stage-structured epidemic models

Stage-structures from various modelling strategies are integrated into standard epidemic models and the global stability of equilibria is consolidated and studied using the graph-theoretic approach.

TOSHIKAZU KUNIYA, Kobe University
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 164]
Global stability analysis for an age-structured multi-group SIR epidemic model

In this study, we investigate the global asymptotic stability of equilibria in a multi-group SIR epidemic model with discrete and continuous age structures. For both discrete and continuous cases, we obtain the basic reproduction number R_0 as the spectral radius of the next generation matrix/operator and show that if $R_0 < 1$, then the disease-free equilibrium is globally asymptotically stable. Furthermore, under the assumption that the disease transmission coefficient is independent from the age of infective individuals and the rate of removal from infective class is age-independent, we show that if $R_0 > 1$, then the endemic equilibrium is globally asymptotically stable. In the proof, we use the well-known graph theoretic approach developed by Professors Guo, Li and Shuai (2006) together with an approach of max function.

MICHAEL LI, University of Alberta
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 164]
Global Stability Problems in Heterogeneous Models for Vector-Borne Diseases

The graph-theoretic approach to the construction of global Lyapunov functions for large-scale dynamical systems, developed by Guo-Li-Shuai, was applied to establish global stability of equilibria in mathematical models of vector-borne diseases in heterogeneous populations. Multi-group and multi-city models for Dengue fever are used as examples.

CONNELL MCCLUSKEY, Wilfrid Laurier University
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 164]
Lyapunov functionals for delay equations with vector borne transmission

Recent work on modifying a Lyapunov function for an ODE to be a Lyapunov functional for a delay differential equation will be presented. In this talk we study the case where the delay comes from vector borne transmission, similar to the situation studied by Ken Cooke in 1979. We build on recent work, identifying conditions under which this "vector-delay" is harmless; it does not disrupt the Lyapunov calculation, and therefore does not affect the global asymptotic stability.

ZHISHENG SHUAI, University of Central Florida
[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 164]
Applications of the graph-theoretic approach to heterogeneous cholera models

The graph-theoretic approach has become a standard method to construct global Lyapunov functions for large-scale differential equation systems. Appropriate graph/network design and reduction is the key in the successful application of the approach. We illustrate these graph/network techniques using various types of cholera models that incorporate heterogenous structures in the host/pathogen (multi-stage or multi-group) and environment (multi-patch or multi-city).

HAITAO SONG, Shanxi University and Lamps York University
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 164]
Global dynamics of two heterogeneous SIR models with nonlinear incidence rate and delays

To investigate the effect of heterogeneity on the global dynamics of two SIR epidemic models with general nonlinear incidence rate and infection delays, we formulate a multi-group model corresponding to the heterogeneity in the host population and a multi-stage model corresponding to heterogeneous stages of infection. Under biologically motivated considerations, we establish that the global dynamics for each of the two models are determined completely by the corresponding basic reproduction number: if the basic reproduction number is less than or equal to one, then the disease-free equilibrium is globally asymptotically stable and the disease dies out in all groups or stages; if the basic reproduction number is larger than one, then the disease will persist in all groups or stages, and there is a unique endemic equilibrium which is globally asymptotically stable. Then we conclude that the heterogeneity does not change the global dynamics of the SIR model when the incidence rate is a general nonlinear function. Our results extend a class of previous results and can be applied to the other epidemiological models. The proofs of the main results use Lyapunov functional and graph-theoretic approach. This is a joint work with Weihua Jiang(HIT) and Shengqiang Liu(HIT).

YASUHIRO TAKEUCHI, Aoyama Gakuin University
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 164]
Maturation delay for the predators can enhance stable coexistence in prey-predator model with Allee effect

We consider a prey-predator model with Allee effects in prey growth and Michaelis-Menten type functional response to describe the grazing pattern. We obtain the conditions for stable and oscillatory coexistence of prey and their specialist predator in case of strong and weak Allee effect in prey growth. Main objective of the present work is to show the stabilizing role of maturation delay in the presence of Allee effect in prey growth. We construct the delayed model by incorporating maturation delay parameter and juvenile predators death rate into the growth equation of predators. Apart from the analytical results for the non-delayed and delayed models, we perform extensive numerical simulations to construct the relevant bifurcation diagrams. We provide the biological implications. We discuss on some problem to construct Lyapunov functionals.

JINLIANG WANG, Heilongjiang University
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 164]
Dynamics of a PDE viral infection model incorporating cell-to-cell transmission

In this talk, I will concern with the global dynamics of a PDE viral infection model with cell-to-cell transmission and spatial heterogeneity. The basic reproduction number $\Re_0$ is obtained in a variational characterization. It is shown that if $\Re_0 \leq 1$, then the infection-free steady state is globally asymptotically stable, while if $\Re_0 > 1$, then the system is uniformly persistent and the infection steady state is globally asymptotically stable. The proof is based on the construction of the appropriate Lyapunov functionals and usage of the Green's first identity together with the LaSalle's invariance principle. In the case of constant parameters, the basic reproduction number $\Re_0$ is easily calculated and the numerical simulation is performed to verify its threshold property.

YANYU XIAO, University of Cincinnati
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 164]
Application of Lyapunov Functions to some vector-borne disease models

We will use some lyapunov functions to examine the global dynamics of some vector-borne disease models.

Notes

Algebraic Design Theory / Théorie de la conception algébrique

Org: Hadi Kharigani (Lethbridge)

Schedule/Horaire **Room/Salle: Education Building 221**

Saturday June 25	**samedi 25 juin**
15:30 - 16:15	Karol Zyczkowski, *On complex Hadamard matrices with special properties*
16:15 - 16:45	Rostam Sabeti, *On classes of periodic parametrized circulant complex Hadamard matrices*

Sunday June 26	**dimanche 26 juin**
15:30 - 16:00	Lucia Moura, *Finite Field Constructions of Combinatorial Arrays*
16:00 - 16:30	Steve Wang, *Some recent progress on Costas arrays*
16:30 - 17:00	David Pike, *On the chromatic index of STS block intersection graphs*
17:00 - 17:30	Asiyeh Sanaei, *Skolem Sequences and Graph Labelling*

Monday June 27	**lundi 27 juin**
8:30 - 9:00	Sho Suda, *Linked systems of symmetric group divisible designs*
9:00 - 9:30	Ferenc SZÖLLŐSI, *Classification algorithms for Butson-type Hadamard matrices*
9:30 - 10:00	Will Orrick, *Maximal determinants, sequence pairs, and cyclotomy*
14:00 - 14:30	Brett Stevens, *Ordered orthognal arrays, LFSRs and hypergraph homomorphisms*
14:30 - 15:00	Rob Craigen, *Synthetic Orthogonality Theory*
15:00 - 15:30	Bill Martin, *Linked systems of symmetric designs and real mutually unbiased bases*

Abstracts/Résumés

ROB CRAIGEN, Manitoba
[Monday June 27 / lundi 27 juin, 14:30 – Education Building 221]
Synthetic Orthogonality Theory

De Launey and Flannery built their now-canonical field of Algebraic Design Theory upon the base assumption that an $m \times n$ array must have the property that all $2 \times n$ subarrays belong to a collection called an **orthogonality set**, thus abstracting, in an axiomatic fashion, a general category of "orthogonality" pertaining to important classes of designs. This seems an interesting, and inevitable, step in the development of an overarching theory encompassing the disparate objects of design theory: step back, set up axioms and see what worlds those axioms open up for exploration. Those worlds are inhabited, of course, by our old familiar friends in design theory, and many other exotic creatures, as yet unexplored.

The next phase of this work was to develop an algebraic framework that would marry this axiomatic approach with the ongoing questions of conventional design theory. Alternatively, they had an a priori notion of where this path should lead, and deliberately pushed forward in that direction.

But what else might have happened? Backtracking to the axiomatic framework, what dictates that one must follow the path of algebraic development? What might we find by allowing those "ground rules" to inform us what this world looks like? If we are led naturally into algebra, so be it ... but where else might we go?

This talk will summarize an alternative path for exploration, beginning with the De Launey-Flannery approach to orthogonality, and some interesting landscapes of that world that do not lie along their established path.

BILL MARTIN, Worcester Polytechnic Institute

[Monday June 27 / lundi 27 juin, 15:00 – Education Building 221]

Linked systems of symmetric designs and real mutually unbiased bases

Let Γ be a finite undirected graph with vertex set X partitioned into w subsets each of size v:

$$X = X_1 \dot\cup X_2 \dot\cup \cdots \dot\cup X_w \ .$$

We say that Γ is a *linked system of symmetric* (v, k, λ) *designs with* w *fibres* if Γ satisfies the following three properties:
• no edge of Γ has both ends in the same fibre X_i;
• the subgraph of Γ induced between any two distinct fibres X_i and X_j is the incidence graph of some symmetric (v, k, λ) design;
• for any three distinct indices i, j, k from $\{1, \ldots, w\}$ and for any $a \in X_i$ and any $b \in X_j$ the number of common neighbors of a and b lying in X_k depends only on whether or not (a, b) is an edge of Γ and not on the choice of a and b or on the choice of i, j, k.

A set of w *mutually unbiased bases* in $\mathbb{R}^d$ ("w real MUBs") is a collection of orthogonal bases $\mathcal{B}_1, \ldots, \mathcal{B}_w$ for $\mathbb{R}^d$ enjoying the property that $|\mathbf{x} \cdot \mathbf{y}|$ is constant whenever $\mathbf{x}$ and $\mathbf{y}$ are chosen from distinct bases $\mathcal{B}_i$ and $\mathcal{B}_j$ from our collection.

In this talk we determine when a linked system of symmetric designs can be converted into a set of real MUBs and give partial results in the reverse direction. The talk is based, in part, on joint work with my student Brian Kodalen.

LUCIA MOURA, University of Ottawa

[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 221]

Finite Field Constructions of Combinatorial Arrays

Finite fields play a fundamental role in the construction of combinatorial designs. In an article of the same title with Gary Mullen and Daniel Panario (Designs, Codes and Cryptography, 2016), we survey constructions of combinatorial arrays using finite fields. These combinatorial objects include orthogonal arrays, covering arrays, ordered orthogonal arrays, permutation arrays, frequency permutation arrays, hypercubes and Costas arrays.

In this talk, I briefly discuss finite field constructions of various types of combinatorial arrays. Then, I focus on constructions of orthogonal arrays and related objects such as variable strength orthogonal arrays, ordered orthogonal arrays and covering arrays. An orthogonal array (and its variants) is an array with q^t rows and k columns on an alphabet with q symbols such that its projection into specific t-subsets of columns give subarrays where each t-tuple of the alphabet occurs once as one of its rows. The orthogonal array variants differ in which t-subsets of columns are required to have this "coverage property". A common theme on several of the recent constructions we discuss is the use of linear feedback shift register sequences of maximum period (m-sequences) to build arrays attaining a high number of t-subsets of columns with the "coverage property". The structure of coverage in the arrays built from intervals of length $(q^t - 1)/(q - 1)$ of these sequences reveal interesting relationships with finite geometry. I will mention different constructions I have worked on with André Castoldi, Sebastian Raaphorst, Daniel Panario, Brett Stevens and Georgios Tzanakis.

WILL ORRICK, Indiana University

[Monday June 27 / lundi 27 juin, 9:30 – Education Building 221]

Maximal determinants, sequence pairs, and cyclotomy

Construction of maximal-determinant matrices using pairs of binary sequences with prescribed autocorrelation properties goes back to the work of Paley and Szekeres in the case of Hadamard matrices, and of Ehlich in the case of matrices of size $n \equiv 2 \pmod 4$. Ehlich's matrices attain the upper bound of Ehlich and Wojtas, which, however, can only be reached under the condition that $n - 1$ be the sum of two integer squares. In certain cases where this condition is not satisfied, new types of sequence pairs discovered about a decade ago produce matrices with determinant approaching the upper bound. We give necessary conditions for the existence of such sequence pairs and describe some methods that have produced solutions up to

$n = 106$. Cyclotomic constructions have been fruitful in the search for sequence pairs that generate Hadamard matrices. We describe recent results, some negative, restricting the types of solutions that can be constructed by cyclotomic methods, and some positive, producing infinite families of solutions.

Joint work with Tomas Rokicki, Adam Vollrath, Yancy Liao.

DAVID PIKE, Memorial University of Newfoundland

[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 221]

On the chromatic index of STS block intersection graphs

Given a combinatorial design, its block intersection graph is obtained by creating a vertex for each block and making vertices adjacent when their blocks have non-empty intersection. The chromatic index $\chi'(G)$ of a graph G is the least number of colours with which the edges can be labelled such that adjacent edges are never of the same colour. For any simple graph of maximum degree $\Delta(G)$, Vizing has established that $\Delta(G) \leq \chi'(G) \leq \Delta(G) + 1$. Here we consider the chromatic index of block intersection graphs of Steiner triple systems. This is joint work with Jonathan Poulin.

ROSTAM SABETI, Olivet College

[Saturday June 25 / samedi 25 juin, 16:15 – Education Building 221]

On classes of periodic parametrized circulant complex Hadamard matrices

This talk is about a novel concept of periodicity for classes of Parametrized Circulant Complex Hadamard (PCCH) matrices associated with solution components of cyclic n-roots. Examples of PCCH matrices of sizes $n = 4, 8, 12, 16$ and 18 with different periods will be presented. Beside applications of CCH matrices in coding and quantum information, the number of PCCH matrices constructed by this method is an evidence to disprove the problematics (for corresponding versions of CHC) set forth by Teodor Banica, Ion Nechita and Jean-Mark Schlenker. As a result of a reformulated Theory and fundamental Theorems, a Combinatorial-Symbolic search algorithm will be used to construct associated PCCH matrix of size $n = 4 \cdot 241$ for the first time.

ASIYEH SANAEI, Kwantlen Polytechnic University

[Sunday June 26 / dimanche 26 juin, 17:00 – Education Building 221]

Skolem Sequences and Graph Labelling

Skolem sequences were introduced in 1950s and have been used to construct combinatorial designs and to answer set partitioning problems. A Skolem-labeled graph can be assumed as a higher dimensional version of a Skolem sequence and the labelling may be used in testing distance reliability of networks. We survey the known results on graphs Skolem labelling and answer the question of whether a generalized Dutch windmill allows such a labelling. In particular, we show that a Dutch windmill composed of two cycles C_m and C_n, $n \geq m$, with a vertex in common does not have a Skolem labelling if and only if $n - m \equiv 3, 5 \pmod 8$ and m is odd, and thereby introducing a novel technique for proving that a Skolem labelling does not exist. "Joint work with Nancy Clarke"

BRETT STEVENS, Carleton University

[Monday June 27 / lundi 27 juin, 14:00 – Education Building 221]

Ordered orthognal arrays, LFSRs and hypergraph homomorphisms

We present a new construction of strength-t ordered orthogonal arrays (OOA) with $(q+1)t$ columns over a finite field $\mathbb{F}_q$ using linear feedback shift registers sequences (LFSRs). OOAs are the combinatorial analogue of (t, m, s)-nets. Our construction selects suitable columns from the circulant array formed from an LFSR sequence determined by a primitive polynomial of degree t. We prove properties about the relative positions of runs in the LFSR which establish the OOA properties. The set of parameters of our OOAs are the same as the ones given by Rosenbloom and Tsfasman (1997) and Skriganov (2002), but the constructed arrays are different: our OOAs cover many more t-sets of columns than the Rosenbloom-Tsfasman-Skriganov OOAs. We also discuss this construction from the point of view of hypergraph homomorphisms.

SHO SUDA, Aichi University of Education
[Monday June 27 / lundi 27 juin, 8:30 – Education Building 221]
Linked systems of symmetric group divisible designs

Symmetric group divisible designs (SGDD) are a generalization of symmetric designs, and are studied by Bose. Inspired by a recent work of uniform association schemes by van-Dam, Martin, and Muzychuk, we introduce a concept of linked systems of SGDD. We will show necessarily conditions for existence, constructions, an equivalence between linked SGDD and association schemes. As a consequence, an upper bound on the number of linked systems of SGDD is obtained.

FERENC SZÖLLŐSI, Aalto University
[Monday June 27 / lundi 27 juin, 9:00 – Education Building 221]
Classification algorithms for Butson-type Hadamard matrices

A Butson-type complex Hadamard matrix H of order n is an $n \times n$ matrix whose entries are all some q-th root of unity satisfying $HH^* = nI$.

In this talk I will review the methods of orderly generation and (weak) canonical augmentation, and demonstrate how to use these tools to search for Butson-type complex Hadamard matrices of small orders.

These efforts are motivated by two long-standing open problems in harmonic analysis and quantum information theory, namely Fuglede's conjecture and the MUB-6 problem.

STEVE WANG, Carleton University
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 221]
Some recent progress on Costas arrays

A Costas array of order n is a $n \times n$ permutation array (with exactly one dot in every row and column and blanks elsewhere) such that every vector connecting two dots are distinct. The Costas property ensures that the array has ideal auto-correlation, which makes Costas arrays highly desired for use in RADAR and SONAR communications. We examine two particular constructions of Costas arrays known as the Taylor variant of the Lempel construction, or the T_4 construction, and the variant of the Golomb construction, or the G_4 construction. We connect these constructions with the concept of Fibonacci primitive roots, and show that under the Extended Riemann Hypothesis the T_4 and G_4 constructions are valid infinitely often. We also confirm Golomb and Moreno's conjecture that every ciricular sequence is Costas if and only if it is exponential Welch.

KAROL ZYCZKOWSKI, Jagiellonian University, Cracow
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 221]
On complex Hadamard matrices with special properties

Two classes of complex Hadamard matrices with certain special properties found recently applications in quantum physics. Consider a four index tensor T_{ijkl} of size M. It can be reshaped into a square matrix $A_{\mu,\nu}$ of size M^2 with three different choices of composed indices e.g. $\mu = (i,j); \nu = (k,l)$ or $\mu = (i,k);\ \nu = (j,l)$, or $\mu = (i,l); \nu = (j,k)$. A tensor T is called $perfect$ if all three matrices A, A' and A'' generated in this way are unitary. A matrix A is called $multiunitary$ if it remains unitary after suitable reshuffling of their entries. Examples of multiunitary complex Hadamard matrices of size 9 are presented. We discuss also skew complex Hadamard matrices and address the question for which size they exist.

Algebraic graph theory: including Cayley graphs, group actions on graphs, graph eigenvalues, graphs and matrices / Théorie des graphes algébrique: graphes de Cayley, actions de groupe sur les graphes, valeurs propres d'un graphe, graphes et matrices

Org: Joy Morris (Lethbridge)

Schedule/Horaire **Room/Salle: Education Building 170**

Saturday June 25	**samedi 25 juin**
9:00 - 9:30	Nathan Lindzey, *Intersecting Families of Perfect Matchings*
9:30 - 10:00	Harmony Zhan, *Quantum Walks and Graph Spectra*
15:30 - 16:00	Robert Bailey, *On the metric dimension of incidence graphs*
16:00 - 16:30	Cathy Kriloff, *Spectra of Cayley graphs of complex reflection groups*
16:30 - 17:00	Shonda Gosselin, *The metric dimension of circulant graphs*
17:00 - 17:30	Joy Morris, *Cyclic m-cycle systems of near-complete graphs*

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Karen Meagher, *Derangement graphs for 2-transitive groups*
9:00 - 9:30	Sean McGuinness, *Hamilton Paths in the Cayley Graph of a Dihedral Group*
9:30 - 10:00	Dave Witte Morris, *Infinitely many nonsolvable groups whose Cayley graphs are hamiltonian*
10:30 - 11:00	Joel Friedman, *Sheaves on Graphs and Applications*
11:00 - 11:30	Adrián Pastine, *Abelian Groups are R-Sequenceable*

Abstracts/Résumés

ROBERT BAILEY, Grenfell Campus, Memorial University
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 170]
On the metric dimension of incidence graphs

A resolving set for a graph Γ is a collection of vertices chosen so that any vertex of Γ is uniquely identified by the list of distances to the chosen few. The metric dimension of Γ is the smallest size of a resolving set for Γ. In this talk, we will consider the incidence graphs of symmetric designs, and show how he probabilistic method can be used to bound their metric dimension. In the case of incidence graphs of Hadamard designs, this result is (asymptotically) best possible.

ROBERT BAILEY, Grenfell Campus, Memorial University
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 170]
On the metric dimension of incidence graphs

A resolving set for a graph Γ is a collection of vertices chosen so that any vertex of Γ is uniquely identified by the list of distances to the chosen few. The metric dimension of Γ is the smallest size of a resolving set for Γ. In this talk, we will consider the incidence graphs of symmetric designs, and show how he probabilistic method can be used to bound their metric dimension. In the case of incidence graphs of Hadamard designs, this result is (asymptotically) best possible.

We explain how the above ideas helped to resolve the Hanna Neumann conjecture, using a symmetry argument for sheaves on Cayley graphs. This symmetry argument was recently "algebrized" by Jaikin-Zapirain, via work of Dicks, to resolve the "pro-p analog" of the Hanna Neumann conjecture.

This talk assumes only basic linear algebra and graph theory. Part of the material is joint work with Alice Izsak, Lior Silberman, and Warren Dicks.

SHONDA GOSSELIN, University of Winnipeg
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 170]
The metric dimension of circulant graphs

A pair of vertices x and y in a graph G are said to be resolved by a vertex w if the distance from x to w is not equal to the distance from y to w. We say that G is resolved by a subset of its vertices W if every pair of vertices in G is resolved by some vertex in W. The minimum cardinality of a resolving set for G is called the metric dimension of G. The problem of determining the metric dimension of a graph is known to be NP-hard (Khuller et al 1994). The metric dimension of a graph has applications in network discovery and verification, combinatorial optimization, chemistry, and many other areas, and consequently this graph parameter has received a great deal of attention from researchers recently, the main goal being to determine the metric dimension of certain classes of graphs. In this talk, we consider the metric dimension of circulant graphs, which are Cayley graphs on cyclic groups that were recently shown to be a class of graphs with bounded metric dimension (Grigorius et al 2014). We present some background on the problem and some new results. This is joint work with my student Kevin Chau.

CATHY KRILOFF, Idaho State University
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 170]
Spectra of Cayley graphs of complex reflection groups

The distance matrix records the length of the shortest path between each pair of vertices in a graph and a graph with integral distance spectrum will be called distance integral. Renteln proved that Cayley graphs of finite real reflection groups with respect to all reflections are distance integral and provided combinatorial formulas for the distance spectrum of the infinite families of such graphs. We extend this result by proving that Cayley graphs of finite complex reflection groups with connection set consisting of all reflections are distance integral. We also provide a combinatorial formula for the distance spectrum for a family of monomial complex reflection groups. This is joint work with Briana Foster-Greenwood.

NATHAN LINDZEY, University of Waterloo
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 170]
Intersecting Families of Perfect Matchings

A family of perfect matchings of K_{2n} is t-intersecting if any two of its members have t edges in common. It has been conjectured that such a family cannot have size larger than $(2(n-t)-1)!!$ for sufficiently large n, and that the extremal families are precisely those comprised of every perfect matching containing a fixed set of t disjoint edges. We discuss a proof of this conjecture, emphasizing the algebraic aspects and techniques surrounding the proof.

SEAN MCGUINNESS, Thompson Rivers University
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 170]
Hamilton Paths in the Cayley Graph of a Dihedral Group

A well-known conjecture states that every connected Cayley graph of order three or greater is Hamiltonian. We shall look at this conjecture in the special case of the Cayley graph of a dihedral group D_n. When n is even, the conjecture is known to be true. We shall look at the case where n is odd. As it turns out, the problem in this case reduces to showing that a certain class of cubic graphs is Hamilton-laceable. We shall present some results which show that Hamilton-laceability is possible so long as the graph is big enough.

KAREN MEAGHER, University of Regina
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 170]
Derangement graphs for 2-transitive groups

The *derangement graph* of a permutation group G is a Cayley graph on G and the connection set is the set of all derangements in G (these are the elements with no fixed points). The eigenvalues of the derangement graph can be calculated using the irreducible characters of the group. The well-known *ratio bound* (also known as the Delsarte-Hoffman ratio bound) uses the eigenvalues of the graph to bound the size of the maximum coclique (or independent set) in the derangement graph. In this talk, I will show how a variant of this bound can be used to prove that the size of the largest coclique in the derangement graph for any 2-transitive group is the size of the stabilizer of a point. This is related to the Erdős-Ko-Rado Theorem for groups.

DAVE WITTE MORRIS, University of Lethbridge
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 170]
Infinitely many nonsolvable groups whose Cayley graphs are hamiltonian

It has been conjectured that if G is any finite group, then every connected Cayley graph on G has a hamiltonian cycle. This conjecture has been verified for numerous groups that either are small or are close to being abelian, but we provide the first verification that includes infinitely many non-solvable groups. More precisely, we exhibit infinitely many primes p, such that every connected Cayley graph on the direct product $A_5 \times \mathbb{Z}_p$ has a hamiltonian cycle (where A_5 is the alternating group on 5 letters).

JOY MORRIS, University of Lethbridge
[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 170]
Cyclic m-cycle systems of near-complete graphs

There are certain straightforward necessary conditions for a graph to be decomposable into cycles of a fixed length m: the valency of every vertex must be even; the number of edges must be divisible by the cycle length. The graphs that are most natural to try to decompose into cycles, are complete graphs K_n. If n is even, then a 1-factor must be removed from the graph so that it meets the first necessary condition, and the resulting graph is denoted by $K_n - I$.

Alspach, Gavlas, and Šajna proved that the necessary conditions are sufficient to ensure an m-cycle decomposition of K_n, or of $K_n - I$. Since K_n has a great deal of symmetry, it is natural to ask whether or not some of that symmetry can carry over into an m-cycle decomposition. We let ρ denote the n-step rotation of the complete graph K_n, or of $K_n - I$ (where the 1-factor that has been removed is chosen so that the graph still has n-step rotational symmetry). An m-cycle system is called cyclic, if for any cycle C in the system, $\rho(C)$ is also in the system.

I will discuss results on cyclic m-cycle systems of K_n and more particularly $K_n - I$, including recent results dealing with the case where m is an even divisor of n.

ADRIÁN PASTINE, Michigan Technological University
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 170]
Abelian Groups are R-Sequenceable

In his 1974 solution to the map colouring problem for all compact 2-dimensional manifolds except the sphere, Gerhard Ringel was led to the following group-theoretic problem: When can the non-identity elements of a group of order n be cyclically arranged in a sequence $g_0, g_1, g_2, ..., g_{n-1}$ such that the quotients $g_i^{-1}g_{i+1}$, $i = 0, 1, 2, ..., n$ (with subscripts modulo n) are all distinct?

The complete Cayley graph X on a group G is the complete directed graph where the edge (x, y) is labeled by $x^{-1}y$. The edges with a given label z in G form a 1-factor F_z and $\{F_z : z \in G\}$ is a 1-factorization of X. A subgraph H of X is an orthogonal subgraph if it contains exactly one edge of each of the one-factors. In this language Ringel's problem asks: For which groups G does the complete Cayley graph X admit an orthogonal directed cycle? In this joint work with Brian Alspach and Donald L. Kreher, we will discuss R-Sequenceability of even ordered abelian groups.

HARMONY ZHAN, University of Waterloo
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 170]
Quantum Walks and Graph Spectra

A quantum walk on a graph X is controlled by the transition matrix $U(t) = exp(itM)$, where M is a matrix associated with X, for example, the adjacency matrix or the Laplacian matrix. We say X admits uniform mixing if for some time t, the transition matrix $U(t)$ is flat. Uniform mixing is a rare, and in determining which graphs enjoy such property, the spectra of the underlying graph plays an essential role. We will present some results about uniform mixing on Cayley graphs, and different algebraic techniques used in the proofs.

Notes

Analysis and applications of differential equations using symmetries, conservation laws, and integrability / Analyse et applications d'éequations différentielles utilisant des symétries, les lois de la conservation et l'intégrabilité

Org: Stephen Anco (Brock) and/et **Alexei Cheviakov** (Saskatchewan)

Schedule/Horaire **Room/Salle: Education Building 170**

Sunday June 26	**dimanche 26 juin**
15:30 - 16:00	George Bluman, *Nonclassical analysis of the nonlinear Kompaneets equation*
16:00 - 16:30	Alexei Cheviakov, *Conservation law construction for the incompressible Mooney-Rivlin hyperelasticity model*
16:30 - 17:00	Dmitry Pshenitsin, *Conservation laws of incompressible magnetohydrodynamics*

Monday June 27	**lundi 27 juin**
8:30 - 9:00	Alexander Odesski, *Integrable structures in 3D hydrodynamic-type systems and differential geometry*
9:00 - 9:30	Thomas Wolf, *Computing Symmetries and Recursion Operators of Evolutionary Super-Sytstems*
9:30 - 10:00	Andy Wan, *Conservative discretization and long term stability*
14:00 - 14:30	Stephen Anco
14:30 - 15:00	Elena Recio, *Multi-peakon solutions in a family of generalized Camassa-Holm equations*

Abstracts/Résumés

STEPHEN ANCO, Brock
[Monday June 27 / lundi 27 juin, 14:00 – Education Building 170]

GEORGE BLUMAN, University of British Columbia
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 170]
Nonclassical analysis of the nonlinear Kompaneets equation

The nonlinear Kompaneets (NLK) equation describes the spectra of photons interacting with a rarefied electron gas. We exhibit five previously unknown classes of explicit time-dependent solutions (each class depending on initial conditions with two parameters) of the NLK equation. It is shown that these solutions cannot be found as invariant solutions using the classical Lie method (solutions obtained by Ibragimov (2010)) but are found using the nonclassical method. Interestingly, each of these

new solutions can be expressed in terms of elementary functions. Three of these solution classes exhibit quiescent behaviour and the other two solution classes exhibit blow-up behaviour in finite time. As a consequence, it is shown that corresponding nontrivial stationary solutions are all unstable. This is joint work with Zhengzheng Yang and Shou-fu Tian. For details, see our paper with the same title in J. Eng. Math 84: 87-97 (2014)

ALEXEI CHEVIAKOV, University of Saskatchewan
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 170]
Conservation law construction for the incompressible Mooney-Rivlin hyperelasticity model

An extended Kovalevskaya form is derived for the two-dimensional incompressible Mooney-Rivlin nonlinear hyperelasticity equations and is used to compute a complete set of local conservation laws of the model through the direct method. Conserved densities and fluxes of the conservation laws are derived, and their physical interpretation is discussed. Since the model admits a variational formulation, the equations are rewritten in the self-adjoint form. Computation of local conservation laws through the direct method applied to the self-adjoint form, as well as a conservation law computation through the local symmetry analysis and the Noether's first theorem, is performed. A correspondence between local variational symmetries and conservation law multipliers is illustrated. It is argued that even though it leads to more complicated forms of multipliers, the direct conservation law construction method applied to the Kovalevskaya form of the equations is a preferred systematic way of conservation law computations for complicated physical models of the type considered in this work, since it yields complete results, and naturally avoids singular multipliers. This is joint work with Simon St. Jean.

ALEXANDER ODESSKI, Brock University
[Monday June 27 / lundi 27 juin, 8:30 – Education Building 170]
Integrable structures in 3D hydrodynamic-type systems and differential geometry

We review the theory of 3D hydrodynamic-type systems and Whitham type hierarchies integrable by hydrodynamic reductions method. This approach to integrability is based on the so-called systems of Gibbons-Tsarev type. We explain that this integrable structure can be represented as a certain differential-geometric structure which is defined locally as a family of vector fields $g(p) = \sum_{i=1}^{m} g_i(p, v_1, ...v_m)\frac{\partial}{\partial v_i}$ with commutation relations

$$[g(p_1), g(p_2)] = f(p_2, p_1)g'(p_1) - f(p_1, p_2)g'(p_2) + 2f(p_2, p_1)_{p_1}g(p_1) - 2f(p_1, p_2)_{p_2}g(p_2)$$

where

$$f(p_1, p_2) = \frac{1}{p_1 - p_2} + O(1)$$

and

$$g(p_2)(f(p_1, p_3)) - g(p_1)(f(p_2, p_3)) = f(p_1, p_2)f(p_2, p_3)_{p_2} - f(p_2, p_1)f(p_1, p_3)_{p_1} + f(p_1, p_3)f(p_2, p_3)_{p_3} - f(p_2, p_3)f(p_1, p_3)_{p_3} + 2f(p_2, p_3)f$$

DMITRY PSHENITSIN, Brock
[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 170]
Conservation laws of incompressible magnetohydrodynamics

A classification of all local conservation laws of kinematic type is obtained for the system of magnetohydrodynamic equations governing incompressible viscous plasmas in which the dynamic and magnetic viscosities are constant. As one new result, conservation of cross-helicity is shown to extend from the ideal case to a special viscous case. A similar classification of conservation laws is derived under reductions by translation symmetries, axial rotation symmetries, and helical symmetries. The results yield many new conservation laws which are expected to be relevant in various physical applications of magnetohydrodynamics.

Authors: S. Anco. D. Pshentsin, T. Wolf

ELENA RECIO, Brock University
[Monday June 27 / lundi 27 juin, 14:30 – Education Building 170]
Multi-peakon solutions in a family of generalized Camassa-Holm equations

A new family of peakon equations depending on an arbitrary nonlinearity power p is introduced. This family generalizes the Camassa-Holm equation and shares one of its Hamiltonian structures. Multi-peakon solutions are derived for all powers p.

ANDY WAN, McGill University
[Monday June 27 / lundi 27 juin, 9:30 – Education Building 170]
Conservative discretization and long term stability

We review a recent method, called the multiplier method, on discretizing ODEs and PDEs so that their conservation laws are exactly preserved at the discrete level. In contrast to geometric numerical integrators, such as symplectic and variational integrators, the multiplier method is applicable for systems even without a symplectic or variational structure, such as dissipative problems. Moreover, we discuss the long term stability and preservation of topological properties of the multiplier method for ODEs.

Reference:

Andy T.S. Wan, Alexander Bihlo, and Jean-Christophe Nave, "The Multiplier Method to Construct Conservative Finite Difference Schemes for Ordinary and Partial Differential Equations", SIAM J. Numer. Anal., 54(1), 86–119, 2016

THOMAS WOLF, Brock
[Monday June 27 / lundi 27 juin, 9:00 – Education Building 170]
Computing Symmetries and Recursion Operators of Evolutionary Super-Sytstems

In the talk we discuss the step-by-step computation of nonlocal recursions for symmetry algebras of nonlinear coupled boson-fermion N = 1 supersymmetric systems by using the SsTools environment.

Notes

Analytic number theory and Diophantine equations / Analyse et applications d'équations différentielles utilisant des symétries, les lois de la conservation et l'intégrabilité

Org: Michael Bennett (UBC) and/et **Patrick Ingram** (Colorado State University)

Schedule/Horaire **Room/Salle: Education Building 228**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Matilde Lalin, *Polylogarithms and multizeta values in Mahler measure*
9:00 - 9:30	Allysa Lumley, *A Zero Density Result for the Riemann Zeta Function*
9:30 - 10:00	Greg Martin
15:30 - 16:00	Nils Bruin, *Obstructions for primitive solutions to* $Ax^3 + By^3 = Cz^2$
16:00 - 16:30	Katherine Stange, *Arithmetic properties of the Frobenius traces defined by a rational abelian variety*
16:30 - 17:00	Amy Feaver
17:00 - 17:30	James Parks, *Low-lying zeros of quadratic Dirichlet L-functions*

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Dimitris Koukoulopoulos, *Sieve weights and their smoothings*
9:00 - 9:30	Amir Akbary, *Lang-Trotter conjecture for two elliptic curves*
9:30 - 10:00	Myrto Mavraki, *Simultaneous torsion points in a Weierstrass family of elliptic curves*
10:30 - 11:00	Alia Hamieh, *Value-distribution of logarithmic derivatives of* L*-functions*
11:00 - 11:30	Peter Cho Ho Lam
15:30 - 16:00	Shabnam Akhtari, *Many Thue equations have no solutions*
16:30 - 17:00	Gary Walsh, *Solving systems of simultaneous Pell equations*
17:00 - 17:30	Karl Dilcher, *Derivatives and fast evaluation of the Witten zeta function*

Abstracts/Résumés

AMIR AKBARY, University of Lethbridge

[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 228]

Lang-Trotter conjecture for two elliptic curves

We propose explicit Euler product representation for the universal conjectural constant in the Lang-Trotter conjecture for two elliptic curves. This is joint work with James Parks (KTH Royal Institute of Technology-Sweden).

SHABNAM AKHTARI, University of Oregon
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 228]
Many Thue equations have no solutions

I will talk about my recent joint work with Manjul Bhargava. We show that a positive proportion of integral binary cubic forms that locally everywhere represent 1 do not globally represent 1. We order all classes of binary cubic forms by their absolute discriminants. We prove the same result for binary forms of any degree greater than 2, provided that these forms are ordered by the maximum of the absolute values of their coefficients.

NILS BRUIN, Simon Fraser University
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 228]
Obstructions for primitive solutions to $Ax^3 + By^3 = Cz^2$

It is classical that the only obstructions for homogeneous quadratic equations to have primitive solutions (x, y, z) are local; the Hasse principle holds. The picture for $Ax^p + By^q = Cz^r$ is much more complicated. A result by Beukers shows that if $1/p + 1/q + 1/r > 1$ then the primitive solutions correspond to rational points on finitely many genus 0 curves (subject to certain local conditions). However, as for instance $x^2 + 31y^2 = 5z^3$ shows, obstructions to primitivity are not just local anymore: there is also a class group that can provide obstructions.

For other exponents, obstructions are no longer directly explained by class groups. We will explore some statistics in the case $(p, q, r) = (3, 3, 2)$ This is joint work with Patrick McMahon.

KARL DILCHER, Dalhousie University
[Sunday June 26 / dimanche 26 juin, 17:00 – Education Building 228]
Derivatives and fast evaluation of the Witten zeta function

We study analytic properties of the Witten zeta function $\mathcal{W}(r, s, t)$, which is also named after Mordell and Tornheim. In particular, we evaluate the function $\mathcal{W}(s, s, \tau s)$ $(\tau > 0)$ at $s = 0$ and, as our main result, find the derivative of this function at $s = 0$, which turns out to be surprisingly simple. These results were first conjectured using high-precision calculations based on an identity due to Crandall that involves a free parameter and provides an analytic continuation. This identity was also the main tool in the eventual proofs of our results. Finally, we derive special values of a permutation sum and study an alternating analogue of $\mathcal{W}(r, s, t)$. (Joint work with Jon Borwein).

AMY FEAVER, The King's University
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 228]

ALIA HAMIEH, University of Lethbridge
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 228]
Value-distribution of logarithmic derivatives of L-functions

In this talk, we describe a method for studying the value-distribution of L-functions based on the Jessen-Wintner theory. This method has been explored recently by Ihara and Matsumoto for the case of logarithmic derivatives of Dirichlet L-functions of prime conductor and by Mourtada and V. K. Murty for the case of logarithmic derivatives of Dirichlet L-functions associated with quadratic characters. We show how one may extend such results to the case of cubic characters. This is a work in progress joint with Amir Akbary.

DIMITRIS KOUKOULOPOULOS, Université de Montréal
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 228]
Sieve weights and their smoothings

I will discuss moments of partially smoothed, truncated divisor sums of the Möbius function. Such divisor sums appear naturally in the theory of the Selberg sieve and they play a key role in the GPY sieve and its recent improvements due to Maynard and Tao. It turns out that if the truncation is smooth enough, the main contribution to the moments comes from almost primes. However, for rougher truncations, the dominant contribution comes from integers with many prime factors.

Analogous questions can be asked for polynomials over finite fields and for permutations, and in these cases the moments

behave rather differently, a rare exception. As we will see, a plausible explanation for this phenomenon is given by studying the analogous sums for Dirichlet characters and obtaining different answers depending on whether or not the character is "exceptional".

This is joint work with Andrew Granville and James Maynard.

MATILDE LALIN, Université de Montréal
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 228]
Polylogarithms and multizeta values in Mahler measure

The Mahler measure of a multivariable polynomial or rational function P is given by the integral of $\log|P|$ where each of the variables moves on the unit circle and with respect to the Haar measure. We will discuss some results involving formulas of Mahler measure of polynomials and rational functions yielding polylogarithms and multizeta values. We will focus specially in families of an arbitrary number of variables.

PETER CHO HO LAM, Simon Fraser University
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 228]

ALLYSA LUMLEY, York University
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 228]
A Zero Density Result for the Riemann Zeta Function

Let $N(\sigma,T)$ denote the number of nontrivial zeros of the Riemann zeta function with real part greater than σ and imaginary part between 0 and T. We provide explicit upper bounds for $N(\sigma,T)$ commonly referred to as a zero density result. In 1940, Ingham showed the following asymptotic result

$$N(\sigma,T) = O(T^{\frac{3(1-\sigma)}{2-\sigma}}\log^5 T).$$

Ramaré recently proved an explicit version of this estimate:

$$N(\sigma,T) \leq 4.9(3T)^{\frac{8}{3}(1-\sigma)}\log^{5-2\sigma}(T) + 51.5\log^2 T,$$

for $\sigma \geq 0.52$ and $T \geq 3.061\cdot 10^{10}$. We discuss a generalization of the method used in these two results which yields an explicit bound of a similar shape while also improving the constants. Furthermore, we present the effect of these improvements on explicit estimates for the prime counting function $\psi(x)$. This is joint work with Habiba Kadiri and Nathan Ng.

GREG MARTIN, UBC
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 228]

MYRTO MAVRAKI, University of British Columbia
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 228]
Simultaneous torsion points in a Weierstrass family of elliptic curves

In 2010, Masser and Zannier proved that there are at most finitely many complex numbers t, not equaling 0 or 1, such that the two points on the Legendre elliptic curve $y^2 = x(x-1)(x-t)$ with x-coordinates 2 and 3 are simultaneously torsion. Recently, Stoll proved that there is in fact no such t, and it is his result that inspires our work. In this talk we will focus on the Weierstrass family of elliptic curves $E_t : y^2 = x^3 + t$, and show that in many instances there is no parameter t such that the points $(a,*)$ and $(b,*)$ are simultaneously torsion in E_t. In contrast to the original approach of Masser and Zannier, our approach is dynamical. We focus on studying whether a and b are simultaneously preperiodic for a Lattès map.

JAMES PARKS, KTH Royal Institute of Technology
[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 228]
Low-lying zeros of quadratic Dirichlet L-functions

In this talk we study the 1-level density of low-lying zeros of Dirichlet L-functions attached to real primitive characters of conductor at most X. We obtain an asymptotic expansion of this quantity with lower order terms in descending powers of $\log X$. We show that this is valid under GRH when the support of the Fourier Transform of the implied even test function ϕ is contained in $(-2,2)$. We also uncover a phase transition when the supremum of the support of $\widehat{\phi}$ reaches 1, where a new lower order term appears. This is joint work with Daniel Fiorilli and Anders Södergren.

KATHERINE STANGE, University of Colorado Boulder
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 228]
Arithmetic properties of the Frobenius traces defined by a rational abelian variety

Let A be an abelian variety over the rationals. Under suitable hypotheses, we formulate a conjecture about the asymptotic behaviour of the Frobenius traces $a_{1,p}$ of A reduced modulo varying primes p. This generalizes a well-known conjecture of S. Lang and H. Trotter from 1976 about elliptic curves. We prove upper bounds for the counting function $\#\{p \leq x : a_{1,p} = t\}$ and we investigate the normal order of the number of prime factors of $a_{1,p}$. This is joint work with Alina Carmen Cojocaru, Rachel Davis and Alice Silverberg.

GARY WALSH, Universite d'Ottawa
[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 228]
Solving systems of simultaneous Pell equations

We survey recent quantitative results on the subject matter, and then focus on the problem of completely solving certain specific families, generalizing a recent result of Jian Hua Chen. This is joint work with Paul Voutier.

Computational Number Theory / Théorie algorithmique des nombres

Org: Kevin Hare (Waterloo) and/et **Patrick Ingram** (Colorado State University)

Schedule/Horaire **Room/Salle: Education Building 176**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Katherine Stange, *Lattice properties of number fields and lattice-based cryptography*
9:00 - 9:30	Charles Samuels, *Using Fibonacci numbers to solve certain extremal problems regarding the Mahler measure*
9:30 - 10:00	Jean-François Biasse, *Quantum algorithms for number theory and their relevance to cryptography*
15:30 - 16:00	Aurore Guillevic, *Computing discrete logarithms in non-prime finite fields*
16:00 - 16:30	Clifton Cunningham, *Lifts of Hilbert modular forms and applications to a conjecture of Gross*
16:30 - 17:00	Renate Scheidler, *Computing Quadratic Function Fields With High 3-Rank Via Cubic Field Tabulation*
17:00 - 17:30	Monireh Rezai Rad, *Jacobian Versus Infrastructure in Real Hyperelliptic Curves*

Sunday June 26	**dimanche 26 juin**
9:00 - 9:30	Eva Curry, *Computational Complexity of Addition with Multidimensional Digit Representations*
9:30 - 10:00	Anton Mosunov, *Some computational evidence on the heuristics of Guy and Selfridge*
10:30 - 11:00	Mike Jacobson, *Statistical Analysis of Aliquot Sequences*
11:00 - 11:30	Danielle Cox, *A Problem on Generating Sets Containing Fibonacci Numbers*

Abstracts/Résumés

JEAN-FRANÇOIS BIASSE, University of South Florida
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 176]
Quantum algorithms for number theory and their relevance to cryptography

I will report on recent results about quantum algorithms for solving computational problems in number theory.

In a recent work in collaboration with Fang Song, I presented the first quantum polynomial time algorithm for computing the S-unit group of a number field for a given set of prime ideals S. This algorithm works for arbitrary classes of number fields, even with large degree. It implies polynomial time algorithms for computing the ideal class group, solving the so-called "Principal Ideal Problem" (PIP), computing ray class groups and solving some norm equations. I will discuss the relevance of the efficient PIP resolution method for cryptography.

In collaboration with David Jao and Anirudh Sankar, I also described a quantum algorithm which finds an isogeny between two given supersingular curves over a finite field. In some cases, this algorithm runs in subexponential time. This can be used to attack quantum-safe cryptographic schemes relying on the hardness of finding an isogeny between two given supersingular curves.

DANIELLE COX, Mount Saint Vincent University
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 176]
A Problem on Generating Sets Containing Fibonacci Numbers

The following problem was posed at the Sixteenth International Conference on Fibonacci Numbers and Their Applications:
Let S be the set generated by these rules: Let $1 \in S$ and if $x \in S$, then $2x \in S$ and $1 - x \in S$; so that S grows in generations:

$$\text{gen}(1) = \{1\}, \text{gen}(2) = \{0, 2\}, \text{gen}(3) = \{-1, 4\} \ldots$$

Prove or disprove that each generation contains at least one Fibonacci number or its negative.
In this talk we will discuss the solution using techniques involving the dragon curve, binary sequences and trees.
This is joint work with Karyn McLellan (Mt. St. Vincent University)

CLIFTON CUNNINGHAM, University of Calgary
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 176]
Lifts of Hilbert modular forms and applications to a conjecture of Gross

This talk concerns two approaches to automorphic representations of general spin groups. First, we review a conjecture of Gross which, given an abelian variety over $\mathbb{Q}$ with trivial endomorphism algebra, predicts the weight and level of an automorphic representation of $\mathrm{GSpin}_{2n+1}(\mathbb{A}_{\mathbb{Q}})$ with matching L-function. Second, we review a lifting procedure which produces automorphic representations of $\mathrm{GSpin}_{2n+1}(\mathbb{A}_{\mathbb{Q}})$ from certain Hilbert modular forms over degree n extensions of $\mathbb{Q}$. We then present examples, identified through computational experimentation, of Hilbert modular forms which produce automorphic representations of $\mathrm{GSpin}_{2n+1}(\mathbb{A}_{\mathbb{Q}})$ coming from certain abelian varieties, as predicted by Gross. Joint with Lassina Dembélé.

EVA CURRY, Acadia University
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 176]
Computational Complexity of Addition with Multidimensional Digit Representations

Vectors with integer entries, like integers, can be represented with a digit representation with a base (radix) matrix and a finite set of digit vectors. Standard algorithms for multi-digit addition can then be extended to new addition algorithms for vectors, beyond the standard component-wise addition. Digit representations for integers, including the base-10 Hindu-Arabic numeration system and binary representations, were major advances in mathematics, enabling efficient computations, with numerous important consequences. We ask whether digit representations for vectors can yield further advances in computational efficiency.

Some surprising results occur in the multidimensional setting: addition may be of quadratic rather than linear complexity ($O(n^2)$ instead of $O(n)$, where n is the length of input), and for some addition tables, the standard multidigit addition algorithm may not terminate. Workarounds exist in some cases, making use of an idea similar to the two's complement algorithm for subtraction in one dimension. This talk will briefly review the construction of multidimensional radix representations, will summarize the work recently completed in the Master's thesis of M. ALmutairi, and will present some variations of the addition algorithm that may simplify multidigit addition in the multidimensional setting.

AURORE GUILLEVIC, University of Calgary and PIMS-CNRS
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 176]
Computing discrete logarithms in non-prime finite fields

Computing discrete logarithms in finite fields is a main concern in cryptography. The best algorithms known are the Number Field Sieve and its variants in medium- and large-characteristic fields (e.g. $GF(p^2)$, $GF(p^{12})$); the Function Field Sieve and the Quasi Polynomial-time Algorithm in small characteristic finite fields (e.g. $GF(2^{4404})$). The last step a.k.a. the initial splitting step of the NFS and FFS algorithms computes a smooth decomposition of a given target. While new improvements have been made to reduce the complexity of the dominating relation collection and linear algebra steps of NFS and FFS, resulting in a smaller database of known logarithms of small elements, the target is still any large element of the finite field, so that finding a smooth enough decomposition over the database becomes harder.

Our present method applies to any finite field of composite extension degree. It exploits the available subfields with a cheap (polynomial-time) linear algebra step, resulting in a much more smooth decomposition of the target. This leads to a new trade-off in the asymptotic complexity of the initial splitting step: it is improved by a factor 2 in the exponent with FFS and $2^{1/3}$ in the exponent with NFS, for any finite field of even extension degree, and with a much smaller smoothness bound.

In medium and large characteristic, it can be combined with Pomerance's Early Abort strategy. In small characteristic, it replaces the Waterloo algorithm of Blake, Fuji-Hara, Mullin and Vanstone. Moreover it reduces the width and the height of the following decreasing tree.

MIKE JACOBSON, University of Calgary
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 176]
Statistical Analysis of Aliquot Sequences

Let $s(n) = \sigma(n) - n$ denote the proper sum of divisors function. 1n his 1976 M.Sc. thesis, Stan Devitt presented theoretical and numerical evidence, using a "new method of factoring called POLLARD-RHO", that the average order of $s(n)/n$ in successive iterations of $s(n)$ (Aliquot sequences) is greater than 1. These results seemingly lent support to the Guy/Selfridge Conjecture that there exist unbounded Aliquot sequences.

In this talk, we describe our on-going efforts to expand and update Devitt's computations, by considering the more-appropriate geometric mean of $s(n)/n$ as opposed to the arithmetic mean considered by Devitt, and greatly extending Devitt's computations using modern factoring algorithms.

This is joint work with K. Chum and R. Guy.

ANTON MOSUNOV, University of Waterloo
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 176]
Some computational evidence on the heuristics of Guy and Selfridge

Let $s(n)$ denote the sum of the proper divisors of a positive integer n. An aliquot sequence is a sequence of the form $n, s(n), s_2(n) = s(s(n)), s_3(n) = s(s(s(n)))$, and so on. In 2003, Bosma and Kane proved that the geometric mean of $s(2n)/(2n)$ exists and is slightly less than one. Recently, Carl Pomerance demonstrated that the geometric means of $s(s(2n))/s(2n)$ and $s(2n)/(2n)$ for $n > 1$ match. Both of these results give a strong probabilistic evidence that most of the aliquot sequences starting with an even number are bounded. In our work, we show that the geometric means of $s_k(2n)/s_{k-1}(2n)$ for $2n \leq X$ exceed one for $X = 2^{37}$ and $k = 6, 7, 8, 9, 10$ when averaged over all n such that $s_k(2n) > 0$. Moreover, as k increases, the geometric means grow, too. However, as k remains fixed, the geometric means decrease with the growth of X, possibly approaching the geometric mean of $s(2n)/(2n)$. This can be counted as a computational evidence both for and against the heuristics of Guy and Selfridge given in 1976 that most of the aliquot sequences starting with an even number should be unbounded.

MONIREH REZAI RAD, University of Calgary
[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 176]
Jacobian Versus Infrastructure in Real Hyperelliptic Curves

Real hyperelliptic curves admit two structures: the Jacobian and the infrastructure. While both structures in real models could be employed for cryptographic purposes, it was not clear which one has better performance in practice.

In this talk, we describe that how exactly the infrastructure and the Jacobian are related. We suggest an alternative distance map for the infrastructure in order to improve the efficiency of this structure. We show that the infrastructure with the new distance and the Jacobian have identical performance in practice for cryptographic sized curves. We support this claim both mathematically and computationally.

CHARLES SAMUELS, Christopher Newport University
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 176]
Using Fibonacci numbers to solve certain extremal problems regarding the Mahler measure

A 2001 article of Dubickas and Smyth studies a modified version of the Mahler measure which they called the $metric\ Mahler\ measure$. Roughly speaking, the metric Mahler measure exposes a family of extremal problems many of which appear to be quite difficult. We discuss a certain collection of special cases which can be reduced to the study of the Fibonacci sequence. In these cases, we shall examine a strategy for computing the values of the metric Mahler measures. Our study also reveals an apparently difficult open problem on the Fibonacci numbers.

RENATE SCHEIDLER, University of Calgary
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 176]
Computing Quadratic Function Fields With High 3-Rank Via Cubic Field Tabulation

We present extensive numerical data on global quadratic function fields whose class group has positive 3-rank, obtained via an adaptation to function fields of a method due to Belabas for finding quadratic number fields of high 3-rank. Our algorithm generates fields of minimal discriminant degree for any given 3-rank. It relies on previous work by he authors for tabulating cubic function fields, but incorporates a significant computational speed-up when the quadratic extension is ramified at infinity. We provide numerical data for discriminant degree up to 11 over the finite fields of respective orders 5, 7, 11 and 13. We compare our data with a variety of heuristics on the density of such fields of a given 3-rank by Friedmann-Washington, Ellenberg et al, Achter, and Garton. In most cases, our our data supports the validity of these heuristics. This is joint work with Mike Jacobson and Pieter Rozenhardt.

KATHERINE STANGE, University of Colorado Boulder
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 176]
Lattice properties of number fields and lattice-based cryptography

I will discuss open questions about number field lattices arising from the Ring Learning with Errors problem in lattice-based cryptography. This hard lattice problem is a promising candidate for post-quantum cryptography. This is joint work with Hao Chen and Kristin Lauter.

Convex and Discrete Geometry, and Geometric Analysis
Géométrie convexe et discrète, et analyse géométrique

Org: Alexander Litvak, **Anna Lytova** and/et **Vladyslav Yaskin** (Alberta)

Schedule/Horaire **Room/Salle: Education Building 254**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Jie Xiao, *Flux-Capacity-Mass*
9:00 - 9:30	Arnaud Marsiglietti, *Do Minkowski averages get progressively more convex?*
9:30 - 10:00	Galyna Livshyts, *On infinitesimal versions of Log-Brunn-Minkowski and related inequalities*
15:30 - 16:00	Muhammad A. Khan, *The geometry of homothetic covering and illumination*
16:00 - 16:30	Matthew Stephen, *On convex intersection bodies and unique determination problems for convex bodies*
16:30 - 17:00	Jaegil Kim, *Distribution functions of sections and projections of convex bodies*
17:00 - 17:30	Ning Zhang, *Grunbaum's inequality and centroid position for projections*

Sunday June 26	**dimanche 26 juin**
9:00 - 9:30	Deping Ye, *On the monotonicity of affine surface areas under the Steiner symmetrization*
9:30 - 10:00	Konstantin Tikhomirov
10:30 - 11:00	Elizaveta Rebrova, *Regularization of the norm of random matrices*
11:00 - 11:30	Shardul Vikram, *A New Approach to the Planar Fractional Minkowski problem via a Curvature Flow*
15:30 - 16:00	Yuriy Zinchenko, *On the curvature of the central path for linear programming*
16:00 - 16:30	Sergii Myroshnychenko, *On polytopes with congruent projections*
16:30 - 17:00	Samuel Reid
17:00 - 17:30	Dario Brooks

Monday June 27	**lundi 27 juin**
8:30 - 9:00	Karoly Bezdek, *Contact numbers for sphere packings*
9:00 - 9:30	Kateryna Tatarko, *On the mean curvature vector of a special class of submanifolds in a Riemannian submersion*
9:30 - 10:00	Ivan Iurchenko, *On affine invariant points*

Abstracts/Résumés

KAROLY BEZDEK, University of Calgary
[Monday June 27 / lundi 27 juin, 8:30 – Education Building 254]
Contact numbers for sphere packings

In discrete geometry, the contact number of a given finite number of non-overlapping spheres was introduced as a generalization of Newton's kissing number. This notion has not only led to interesting mathematics, but has also found applications in the science of self-assembling materials, such as colloidal matter. In this talk, we investigate the problem in general and emphasize

important special cases including contact numbers of minimally rigid and totally separable sphere packings. We also discuss the complexity of recognizing contact graphs in a fixed dimension. Moreover, we list some conjectures and open problems. This is a joint work with Muhammad A. Khan (University of Calgary).

DARIO BROOKS, Dalhousie
[Sunday June 26 / dimanche 26 juin, 17:00 – Education Building 254]

IVAN IURCHENKO, University of Alberta
[Monday June 27 / lundi 27 juin, 9:30 – Education Building 254]
On affine invariant points

Affine invariant point is a function f from the set of convex bodies in $\mathbb{R}^n$ into $\mathbb{R}^n$ satisfying the condition $f(\varphi(K)) = \varphi(f(K))$ for any convex body K and any affine transformation φ. We design a new class of affine invariant points. Denoting by $\mathcal{F}$ the set of all affine points we answer the question by Grünbaum how big is the set $\{f(K) \mid f \in \mathcal{F}\}$ for any given convex body K.

MUHAMMAD A. KHAN, University of Calgary
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 254]
The geometry of homothetic covering and illumination

At a first glance, the problem of illuminating the boundary of a convex body by minimal number of external light sources and the problem of economically covering a convex body by its smaller positive homothetic copies appear to be quite different. They are in fact two sides of the same coin and give rise to one of the important longstanding open questions in discrete geometry, namely, the Illumination Conjecture – also known as the Hadwiger Conjecture or the Covering Conjecture. In this talk, we discuss recent advances towards this conjecture and some approaches to potentially make further progress. Moreover, we describe some of our new results in this direction. This is joint work with Károly Bezdek (University of Calgary).

JAEGIL KIM, University of Alberta
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 254]
Distribution functions of sections and projections of convex bodies

Typically, when we are given the section (or projection) function of a convex body, it means that in each direction we know the size of the central section (or projection) perpendicular to this direction. Suppose now that we can only get the information about the sizes of sections (or projections), and not about the corresponding directions. In this talk we will discuss to what extent the distribution function of the areas of central sections (or projections) of a convex body can be used to derive some information about the body, its volume, etc. (Joint work with V. Yaskin and A. Zvavitch)

GALYNA LIVSHYTS, Georgia Institute of Technology
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 254]
On infinitesimal versions of Log-Brunn-Minkowski and related inequalities

Log-Brunn-Minkowski conjecture was proposed by K.J. Boroczky, E. Lutwak, D. Yang and G. Zhang, and it suggests a strengthening of the classical Brunn-Minkowski inequality in the case of symmetric convex sets.

We determine the infinitesimal version of the log-Brunn-Minkowski inequality. As a consequence, we obtain a strong Poincare-type inequality in the case of unconditional convex sets, as well as symmetric convex sets on the plane.

Using it, we establish the validity of the log-Brunn-Minkowski inequality for any pair of symmetric convex sets which are close enough to a Euclidean ball of any radius. We also establish the validity of dimensional Brunn-Minkowski inequality for any pair of (not necessarily symmetric) convex sets near a ball, with respect to a rotation invariant log-concave measure.

ARNAUD MARSIGLIETTI, IMA, University of Minnesota
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 254]
Do Minkowski averages get progressively more convex?

Let us define, for a compact set $A \subset \mathbb{R}^n$, the Minkowski averages of A:

$$A(k) = \left\{ \frac{a_1 + \cdots + a_k}{k} : a_1, \ldots, a_k \in A \right\} = \frac{1}{k}\Big(\underbrace{A + \cdots + A}_{k \text{ times}}\Big).$$

Shapley, Folkmann and Starr (1969) proved that $A(k)$ converges to the convex hull of A in Hausdorff distance as k goes to ∞. Bobkov, Madiman and Wang (2011) conjectured that when one has convergence in the Shapley-Folkmann-Starr theorem in terms of a volume deficit, then this convergence is actually monotone. More precisely, they conjectured that $|A(k)|$ is non-decreasing, where $|\cdot|$ denotes Lebesgue measure.

In this talk, we show that this conjecture holds true in dimension 1 but fails in dimension $n \geq 12$. We also consider whether one can have monotonicity when measured using alternate measures of non-convexity, including the Hausdorff distance, effective standard deviation, and a non-convexity index of Schneider.

(Joint work with Matthieu Fradelizi, Mokshay Madiman and Artem Zvavitch.)

SERGII MYROSHNYCHENKO, Kent State University
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 254]
On polytopes with congruent projections

Let P and Q be two polytopes in $\mathbb{E}^n$, $n \geq 3$, such that their projections onto any k-dimensional subspace, $2 \leq k \leq n-1$, are congruent (i.e. coincide up to a rigid motion). We show that P and Q coincide up to translation and reflection in the origin."

ELIZAVETA REBROVA, University of Michigan
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 254]
Regularization of the norm of random matrices

We study $n \times n$ matrices A with i.i.d. entries having zero mean and unit variance. If the entries are also subgaussian, then the operator norm $\|A\| \sim O(\sqrt{n})$ with high probability, but without subgaussian assumption the norm can be much larger, in some examples it is up to $O(n)$.

So, we are motivated by the question: what is it in the structure of a heavy-tailed matrix that makes its norm to blow up? We show that with high probability the problem is "local": there is a $\varepsilon n \times \varepsilon n$ sub-matrix A_0 (for any $\varepsilon > 0$, i.e. as small as we want), deletion of which regularizes the norm

$$\|A \setminus A_0\| \leq C(\varepsilon)\sqrt{n}$$

We will also discuss the dependence of the norm constant $C(\varepsilon)$ on size parameter ε (we have it optimal up to a logarithmic factor) and how second moment condition is crucial for any "local" regularization. This is a joint work with Roman Vershynin.

SAMUEL REID, Calgary
[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 254]

MATTHEW STEPHEN, University of Alberta
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 254]
On convex intersection bodies and unique determination problems for convex bodies

We describe a general result which ensures counter-examples for certain problems of unique determination for convex bodies. Using this result, we show a convex body $K \subset \mathbb{R}^n$ is not uniquely determined by its convex intersection body $CI(K)$, introduced by Meyer and Reisner in 2011.

KATERYNA TATARKO, University of Alberta
[Monday June 27 / lundi 27 juin, 9:00 – Education Building 254]
On the mean curvature vector of a special class of submanifolds in a Riemannian submersion

We examine the extrinsic geometry of submanifolds which are generated by the restriction of a Riemannian submersion to submanifolds in the base. In particular, we give a representation of the mean curvature vector of submanifolds of the restriction type in the Riemannian submersion space. Joint work with A. Yampolsky.

KONSTANTIN TIKHOMIROV, Alberta
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 254]

SHARDUL VIKRAM, Concordia University
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 254]
A New Approach to the Planar Fractional Minkowski problem via a Curvature Flow

We will present a planar anisotropic curvature flow on the space of smooth, symmetric and strictly convex bodies of the Euclidean plane. We study its long term existence and show that the solutions of the flow converge subsequentially to a solution of the planar L_p-Minkowski problem for $0 < p < 1$. The proof relies on the monotonicity and uniform boundedness of a functional of the flow, called entropy, and on a planar case of the logarithmic Minkowski inequality. (Joint work with A. Stancu.)

JIE XIAO, Memorial University
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 254]
Flux-Capacity-Mass

This talk will address an optimal relationship among entropy flux, electric capacity and graphic mass.

DEPING YE, Memorial University of Newfoundland
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 254]
On the monotonicity of affine surface areas under the Steiner symmetrization

The affine surface area and its extensions are central notions in convex geometry. They have important applications in, for instance, approximation of convex bodies by polytopes, valuation theory, and information theory.

In this talk, I will discuss how the L_p and general affine surface areas change under the Steiner symmetrization. The monotonicity will lead to (stronger) affine isoperimetric inequalities.

NING ZHANG, University of Alberta
[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 254]
Grunbaum's inequality and centroid position for projections

Asymptotic geometry expresses various properties of geometric objects as quantities dependent on the dimension. In this talk, a joint work with Matthew Stephen is presented, which gives the best constant for Grunbaum's inequality for projections and interpret Bonnesen and Fenchel's one-dimensional Grunbaum's inequality as an upper bound for the distance ratio.

YURIY ZINCHENKO, University of Calgary
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 254]
On the curvature of the central path for linear programming

Similarly to the diameter of a polytope, one may define its curvature based on the worst-case central path associated with solving an LP posed over the polytope. Furthermore, a continuous analogue of the Hirsch conjecture and a discrete analogue of the "average curvature" result of Dedieu, Malajovich and Shub may be introduced. A continuous analogue of the result of Holt and Klee –a polytope construction that attains a linear order largest total curvature– and a continuous analogue of a d-step equivalence result for the diameter of a polytope may also be proved. We survey the recent progress towards better understanding of the curvature.

Geometric Methods in Mechanics and Control with Applications / Méthodes géométriques en mécanique et en contrôle avec applications

Org: Vakhtang Poutkaradze (Alberta) and/et **Dmitry Zenkov** (Math, NCSU)

Schedule/Horaire **Room/Salle: Education Building 380**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Hiroaki Yoshimura
9:00 - 9:30	Melvin Leok, *Interpolation on Symmetric Spaces via the Generalized Polar Decomposition*
9:30 - 10:00	Francois Gay-Balmaz
15:30 - 16:00	Richard Cushman
16:00 - 16:30	Jedrzej Sniatycki, *Quantum Spherical Pendulum*
16:30 - 17:00	Vakhtang Putkaradze, *Geometric approach to the dynamics of tubes conveying fluid*

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Paula Balseiro, *Nonholonomic systems and the hamiltonization problem*
9:00 - 9:30	Andrew Lewis, *Tautological Control Systems*
9:30 - 10:00	Stuart Rogers, *Optimal Control of a Nonholonomic Mechanical System*
10:30 - 11:00	Mark Gotay
11:00 - 11:30	Dmitry Zenkov, *The Helmholtz Conditions and the Method of Controlled Lagrangians*
15:30 - 16:00	George Patrick
16:00 - 16:30	Florin Diacu
16:30 - 17:00	Larry Bates

Abstracts/Résumés

PAULA BALSEIRO, Universidade Federal Fluminense, Brazil
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 380]
Nonholonomic systems and the hamiltonization problem

In this talk we will discuss geometric features of nonholonomic systems and their behavior after a reduction by a group of symmetries.

In particular, we will show how the failure of the Jacobi identity is modified after a reduction by symmetries and also by considering 'gauge related brackets'. We will present some concrete examples where Poisson and twisted Poisson brackets appear in the description of the reduced dynamics. In these cases, we will also discuss the role of conserved quantities.

LARRY BATES,
[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 380]

RICHARD CUSHMAN,
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 380]

FLORIN DIACU,
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 380]

FRANCOIS GAY-BALMAZ,
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 380]

MARK GOTAY,
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 380]

MELVIN LEOK, University of California, San Diego
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 380]
Interpolation on Symmetric Spaces via the Generalized Polar Decomposition

We construct interpolation operators for functions taking values in a symmetric space — a smooth manifold with an inversion symmetry about every point. Key to our construction is the observation that every symmetric space can be realized as a homogeneous space whose cosets have canonical representatives by virtue of the generalized polar decomposition — a generalization of the well-known factorization of a real nonsingular matrix into the product of a symmetric positive-definite matrix times an orthogonal matrix. By interpolating these canonical coset representatives, we derive a family of structure-preserving interpolation operators for symmetric space-valued functions. As applications, we construct interpolation operators for the space of Lorentzian metrics, the space of symmetric positive-definite matrices, and the Grassmannian. In the case of Lorentzian metrics, our interpolation operators provide a family of finite elements for numerical relativity that are frame-invariant and have signature which is guaranteed to be Lorentzian pointwise. We illustrate their potential utility by interpolating the Schwarzschild metric numerically. This is joint work with Evan Gawlik.

ANDREW LEWIS, Queen's University
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 380]
Tautological Control Systems

A framework for geometric control theory is presented. The objectives of the framework are: (1) to be independent of any parameterisation of controls, cf. coordinate-invariance in differential geometry; (2) to be able to seamlessly incorporate real analytic system models; (3) to permit general control sets; (4) to incorporate locally defined data. The putting in place of these objectives is intended to ensure that models do not obstruct any understanding of their fundamental structural properties, e.g., controllability, stabilisability, optimality. The meaning of each of these objectives is explained, and a framework achieving them is presented. The framework requires suitable topologies for spaces of vector fields, particularly real analytic vector fields. The use of topologies allows a unified treatment of different regularity classes: finitely differentiable, Lipschitz, smooth, real analytic. This, per se, provides some interesting results concerning the flows of vector fields depending measurably on time.

GEORGE PATRICK,
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 380]

VAKHTANG PUTKARADZE, University of Alberta
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 380]
Geometric approach to the dynamics of tubes conveying fluid

We derive a fully three-dimensional, geometrically exact theory for flexible tubes conveying fluid. The theory also incorporates the change of the cross-section available to the fluid motion during the dynamics, sometimes called collapsible tubes. Our approach is based on the symmetry-reduced, exact geometric description for elastic rods, coupled with the fluid transport and subject to the volume conservation constraint for the fluid. Using these methods, we derive the fully three dimensional

equations of motion. We then proceed to the linear stability analysis and show that our theory introduces important corrections to previously derived results, both in the consistency at all wavelength and in the effects arising from the dynamical change of the cross-section. We also derive and analyze several analytical, fullynonlinear solutions of traveling wave type in two dimensions. Finally, time permitting, we present the variational scheme for discretization of dynamics. This research has been supported by NSERC and the University ofAlberta.

STUART ROGERS, University of Alberta
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 380]
Optimal Control of a Nonholonomic Mechanical System

This talk investigates the optimal control of a mechanical system with nonholonomic constraints. Suslov's problem is an algebraically simple and classical example of a nonholonomic mechanical system. This mechanical system considers the motion of a rigid body rotating about its center of mass subject to the constraint $\Omega(t) \cdot \xi(t) = 0$, where $\Omega(t)$ denotes the rigid body's angular velocity and $\xi(t)$ is a prescribed time-varying vector, both expressed in the rigid body's body frame. First, the pure equations of motion of this nonholonomic mechanical system are derived. Next, letting $\xi(t)$ serve as the control, the optimal control equations of motion are derived that obey the pure equations of motion, satisfy prescribed initial and terminal boundary conditions, and minimize the time integral of a prescribed cost function $C(t, \Omega(t), \dot{\Omega}(t), \xi(t), \dot{\xi}(t))$. Finally, numerical solutions of the optimal control equations are presented.

JEDRZEJ SNIATYCKI, Universities of Victoria and Calgary
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 380]
Quantum Spherical Pendulum

Spherical pendulum is an example of a completely integrable system with globally defined continuous action functions. Since the derivatives of actions are discontinuous, we do not have global angle variables (monodromy). Nevertheless, the quantum states of the spherical pendulum, defined by the Bohr-Sommerfeld conditions, form a 2-dimensional lattice with boundary. Operators of shifting along the generators of the lattice are well defined and lead to a full quantum theory of the spherical pendulum.

HIROAKI YOSHIMURA,
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 380]

DMITRY ZENKOV, North Carolina State University
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 380]
The Helmholtz Conditions and the Method of Controlled Lagrangians

The method of controlled Lagrangians is a technique for deriving stabilizing feedback controls for nonlinear mechanical systems. It relies on constructing a Lagrangian which describes the feedback controlled dynamics. The talk will review the connections between the classical inverse problem of the calculus of variations and the method of controlled Lagrangians. This is a joint work with Anthony Bloch and Demeter Krupka

Notes

Industrial Mathematics / Mathématiques industrielles

Org: Huaxiong Huang (York), **Michael Lamoureux** (Calgary) and/et **Odile Marcotte** (UQAM)

Schedule/Horaire **Room/Salle: Education Building 377**

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Ian Frigaard, *Cementing fluid mechancs*
9:00 - 9:30	Arian Novruzi, *Modeling, shape analysis and computation of the equilibrium pore shape near a PEM–PEM intersection*
9:30 - 10:00	Wenyuan Liao, *A Helmholtz-decomposition based numerical method for Elastic wavefield separation*
10:30 - 11:00	Paul McNicholas
11:00 - 11:30	Hongmei Zhu
15:30 - 16:00	Sean Bohun, *The Pixel Imaging Mass Spectrometer: towards reconstructing molecules*
16:00 - 16:30	Oscar Lopez, *Off-the-Grid Low-Rank Matrix Recovery: Seismic Data Reconstruction*

Monday June 27	**lundi 27 juin**
8:30 - 9:00	Matt Davison
9:00 - 9:30	Anthony Ware
9:30 - 10:00	Vahktang Poutkaradze

Abstracts/Résumés

SEAN BOHUN, University of Ontario Institute of Technology
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 377]
The Pixel Imaging Mass Spectrometer: towards reconstructing molecules

Pixel Imaging Mass Spectrometry is a new molecular imaging technique that relies on precision laser pulses to both align and strip molecules of their valence electrons thereby causing them to explode. The primary task of this experimental setup is the reconstruction of the disintegrated parent molecule through the systematic collection of the fragments of the explosion. The unique characteristics of the experimental setup provide an unprecedented resolution from other techniques. Experimentally obtained covariance maps reveal a partially hidden rich structure of the parent molecule and fragmentation dynamics. However, for larger molecules, the large number of fragment ions that are produced congest the the resulting time-of-flight spectrum and alternative strategies are required to resolve the structure of the parent molecule.

The underlying mathematical challenges of this problem that are unique to the pixel imaging mass spectrometer will be discussed, and a comparison of the forward model predictions with experimental data for the imaging of 3,5-dibromo-3',5'-difluoro-4'-cyanobiphenyl molecule will be presented. A brief survey of the established reconstruction methods for this type of problem will also be discussed.

MATT DAVISON, Western
[Monday June 27 / lundi 27 juin, 8:30 – Education Building 377]

IAN FRIGAARD, University of British Columbia
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 377]
Cementing fluid mechancs

Oil and gas wells undergo cementing operations during construction, remediation and eventually abandonment. From a fluid-dynamical perspective the in situ fluid must be replaced by another fluid. In general both fluids are fine colloidal suspensions, having the dominant rheological characteristics of yield stress, shear thinning fluids, e.g. drilling muds, spacer fluids and cement slurries. In order to achieve a good hydraulic seal of the well, drilling fluid must be removed from the walls and cement contamination be minimized. We present flow results related to these processes, including visco-plastic displacement flows in pipes, eccentric annuli, channels and washouts. A key question concerns the identification of stationary regions of the displaced fluid. This is done for single and multi-fluid flows. Analytical and computational results are supplemented by experiment results conducted in a pipe loop that show surprising complexity. Mathematically these flows involve the Navier-Stokes equations in various forms and many different techniques are needed to "solve" problems and give meaningful answers that others can use.

WENYUAN LIAO, University of Calgary
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 377]
A Helmholtz-decomposition based numerical method for Elastic wavefield separation

In an elastic migration or inversion problem, the P and S waves are trated separately, thus efficient numerical solver is required to compute P and S wavefields. Direct solution of an Elastic wave equation is computationally costly, as it is a coupled system of partial differential equations (PDE). Numerical solution of such model is of great interests to both Mathematicians and Geophysicists working on a variety of applications, geophysical exploration for instance. In particular numerical modeling of Elastic wave equation is an integral part of full waveform inversion and other wave equation based seismic inversion methods. Here we propose a new method, in which we first use the Helmholtz decomposition to decouple the Elastic wave equation system into four scalar acoustic wave equations, which are then efficiently solved by compact higher-order finite difference method with high accuracy. Some novel boundary treatments have been developed for the new equations. The numerical solution of the Elastic wave equation is reconstructed from the previously obtained numerical solutions of the four scalar PDEs. Finally numerical examples are solved to demonstrate the efficiency and effectiveness of the newly proposed numerical method.

OSCAR LOPEZ, University of British Columbia
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 377]
Off-the-Grid Low-Rank Matrix Recovery: Seismic Data Reconstruction

This talk discusses a modified low-rank matrix recovery work-flow that admits unstructured observations. By incorporating a regularization operator which accurately maps structured data to unstructured data, into the nuclear-norm minimization problem, this approach is able to compensate for data irregularity. Furthermore, by construction this formulation yields output that is supported on a structured grid. Recovery error bounds are established for the methodology with matrix sensing and matrix completion numerical experiments including applications to seismic trace interpolation to demonstrate the potential of the approach.

PAUL MCNICHOLAS, McMaster
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 377]

ARIAN NOVRUZI, University of Ottawa
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 377]
Modeling, shape analysis and computation of the equilibrium pore shape near a PEM–PEM intersection

We study the equilibrium shape of an interface that represents the lateral boundary of a pore channel embedded in an elastomer. The model representing this phenomena consists of a system of PDEs, comprising a linear elasticity equation for displacements within the elastomer and a nonlinear Poisson equation for the electric potential within the channel (filled with

protons and water). To determine the equilibrium interface, a variational approach is employed. We analyze: (i) the existence and uniqueness of the electrical potential, (ii) the shape derivatives of state variables and (iii) the shape differentiability of the corresponding energy and the corresponding Euler–Lagrange equation. The latter leads to a modified Young–Laplace equation on the interface. This modified equation is compared with the classical Young–Laplace equation by computing several equilibrium shapes, using a fixed point algorithm.

VAHKTANG POUTKARADZE, Alberta
[Monday June 27 / lundi 27 juin, 9:30 – Education Building 377]

ANTHONY WARE, Calgary
[Monday June 27 / lundi 27 juin, 9:00 – Education Building 377]

HONGMEI ZHU, York
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 377]

Mathematics Outreach Programs: Reach Out, Reach Wide, Reach Deep /Programmes de sensibilisation aux mathématiques: promouvoir les maths partout et pour tous

Org: Gerda de Vries (Alberta), **Malgorzata Dubiel** (SFU) and/et **Veselin Jungic** (SFU)

Schedule/Horaire **Rooms/Salles: ED N2 115, Education Building 303**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Veselin Jungic, Education Building 303, *The Math Catcher Outreach Program*
9:00 - 9:30	Genevieve Fox, Education Building 303, *Integrating Siksikaitsitapi Knowledge into Lifelong Learning Education in Mathematics and Science*
9:30 - 10:00	Melania Alvarez, Education Building 303, *A clean slate: Let them show us their talents.*
15:30 - 16:30	Navajo Math Circles, ED N2 115, *Navajo Math Circles*
16:30 - 17:00	Pamini Thangarajah, ED N2 115, *Explore IT: A Science, Technology, Engineering, and Mathematics (STEM) Outreach for grade nine girls*
17:00 - 17:30	Danielle Cox, Svenja Huntemann, ED N2 115, *How to Develop a Mathematics Outreach Program*

Abstracts/Résumés

MELANIA ALVAREZ, Pacific Institute for the Mathematical Sciences
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 303]
A clean slate: Let them show us their talents.

Do students belonging to an ethnic minority have to deal with ethnic stereotypes on a daily basis? I will be discussing some of the realities ethnic minority students confront at school which can have significant repercussions in their school performance and future prospects.

GENEVIEVE FOX, Siksika Board OF Education
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 303]
Integrating Siksikaitsitapi Knowledge into Lifelong Learning Education in Mathematics and Science

Oki and greetings to all Educators, this session will discuss the plans to enhance the mathematics and science programs in the Siksika Board of Education through the integration of the Siksikaitsitapi (Blackfoot Confederacy) Indigenous Knowledge starting with the middle grades on the Siksika Nation. The program will inculde Siksika Nation history, Elder's and Knowledge Keepers, astronomers, science and math teachers in the creation of this unique program that will motivate and encourage the students to engage and understand the knowledge inherent in the Indigenous People of the Blackfoot Confederacy.

DANIELLE COX, SVENJA HUNTEMANN, Mount Saint Vincent University
[Saturday June 25 / samedi 25 juin, 17:00 – ED N2 115]
How to Develop a Mathematics Outreach Program

More academic institutions are putting an emphasis on the importance of community outreach. In this talk we will look at the steps involved in creating and maintaining a successful math outreach program. We will discuss some of the obstacles that one can face and how to overcome them. Time permitting, we will provide some examples of activities that NS Math Circles has put together for their outreach program. This talk will be presented by Danielle Cox (MSVU) and Svenja Huntemann (Dalhousie)

VESELIN JUNGIC, SFU
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 303]
The Math Catcher Outreach Program

The Math Catcher program is a science outreach initiative at Simon Fraser University, British Columbia, with the objective of promoting mathematics among elementary and high school students, focusing on members of Aboriginal communities both in urban settings and on reserves. The storytelling, pictures, models, and hands-on activities encourage young people to enjoy math and help dispel myths that math is boring and solely abstract.

In this presentation we will, besides describing the aims and the main components of the program, give a brief summary of the current state of math education among Aboriginal population in British Columbia.

NAVAJO MATH CIRCLES, Documentary
[Saturday June 25 / samedi 25 juin, 15:30 – ED N2 115]
Navajo Math Circles

Navajo Math Circles follows Navajo students in a lively collaboration with mathematicians. The math circles approach puts children in charge of exploring mathematics to their own joy and satisfaction. Applications of math in Native culture highlight the special connections between Navajo culture, natural beauty, and mathematics.

PAMINI THANGARAJAH, Mount Royal University
[Saturday June 25 / samedi 25 juin, 16:30 – ED N2 115]
Explore IT: A Science, Technology, Engineering, and Mathematics (STEM) Outreach for grade nine girls

The Explore IT Conference was developed in 1999 to increase girls' awareness of opportunities in information and communications technologies. This annual conference, held simultaneously at the University of Calgary, SAIT Polytechnic, and Mount Royal University. This event stresses the importance of studying higher-level mathematics and science courses in high school. In this talk, I will give an overview of this conference and, outline some hands on technology sessions in mathematics.

Partial Differential Equations / Équations aux dérivées partielles

Org: Mostafa Fazly (Alberta) and/et **Juncheng Wei** (UBC)

Schedule/Horaire **Room/Salle: Education Building 276**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Stephen Gustafson, *Stability of periodic waves of 1D nonlinear Schrödinger equations*
9:00 - 9:30	Dimitrios Roxanas, *Global solutions of a focusing energy-critical heat equation*
9:30 - 10:00	Matt Coles, *Subcritical Perturbations of Energy Critical NLS*
15:30 - 16:00	Xinwei Yu, *Regularity criteria of 3D Navier-Stokes Equations involving the pressure term*
16:00 - 16:30	M. Niksirat, *On the existence of periodic solutions to nonlinear evolution equations*
16:30 - 17:00	Alexei Cheviakov, *Conservation laws of vorticity-type equations*
17:00 - 17:30	Eric Sawyer

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Brendan Pass, *Multi - to one - dimensional transportation*
9:00 - 9:30	Jerome Vetois, *Clustering solutions for smooth perturbations of a critical elliptic equation in low dimensions*
9:30 - 10:00	Weiwei Ao, *Existence of positive solutions with a prescribed singular set of fractional Yamabe Problem*
10:30 - 11:00	Ihsan Topaloglu, *Small volume fraction limit of a nonlocal isoperimetric problem with confinement*
11:00 - 11:30	Eric Woolgar, *Ricci flow of partially even metrics*
15:30 - 16:00	Cristian Rios, *Harnack's estimates for fractional powers of non-symmetric second order operators*
16:00 - 16:30	Chunhua Ou, *Periodic steady-state solutions to the liquid film flowing model: existence and stability*
16:30 - 17:00	Theodore Kolokolnikov, *A novel PDE model of aggregation formation in bacterial colonies*

Abstracts/Résumés

WEIWEI AO, ubc

[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 276]

Existence of positive solutions with a prescribed singular set of fractional Yamabe Problem

In this paper, we consider the problem of the existence of positive solutions with prescribed isolated singularities of

$$\begin{cases} (-\Delta)^s u = u^{\frac{n+2s}{n-2s}} \text{ in } R^n \\ u(x) \to \infty \text{ as } x \to \Sigma \end{cases}$$

where Σ is a set of discrete points in R^n. Near each singular point, these solutions are approximated by the Delaunay-type singular solution which has been studied recently by De la Torre, Del Pino, Mar Gonzalez and J.C. Wei. Away from the singular

points, these solutions are approximated by the summation of the Green's function. This result is the analogous result for the classical Yamabe problem studied by Mazzeo and Pacard (1999). This is a joint work with De la Torre, Mar Gonzalez and J.C. Wei.

ALEXEI CHEVIAKOV, University of Saskatchewan
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 276]
Conservation laws of vorticity-type equations

Partial differential equations (PDE) of the form $\operatorname{div}\vec{N} = 0$, $\vec{N}_t + \operatorname{curl}\vec{M} = 0$ involving two vector functions $\vec{N}, \vec{M} \in \mathbb{R}^3$ that depend on t, x, y, z arise as subsets of PDE systems in various models, including the vorticity formulation of viscous and inviscid fluid dynamics, plasma physics (magnetohydrodynamics), and Maxwell's equations. We refer to these equations as "vorticity-type equations".

It is shown that vorticity-type equations have a special structure of a lower-degree (degree two) conservation law in $\mathbb{R}^4(t, x, y, z)$. Moreover, they form an abnormal PDE system, in the sense of possessing an identically vanishing differential consequence. Even though vorticity-type equations are not variational, a result similar to the Noether's second theorem holds: these equations admit an infinite-dimensional family of conservation laws involving an arbitrary function of all variables. Applications of these conservation laws and related results are discussed.

MATT COLES, University of British Columbia
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 276]
Subcritical Perturbations of Energy Critical NLS

The 3D energy critical focusing nonlinear Schrödinger equation (NLS) admits the so called Aubin-Talenti standing wave solutions. These functions were crucial in Kenig and Merle's 2006 scattering result. We will consider the above equation but whose nonlinearity is perturbed by a small subcritical term. We construct solitary wave solutions as perturbations of the Aubin-Talenti function by means of Lyapunov-Schmidt reduction and resolvent expansion. We further demonstrate these solutions to be ground states and use them to achieve a scattering result in the spirit of Kenig and Merle.

STEPHEN GUSTAFSON, University of British Columbia
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 276]
Stability of periodic waves of 1D nonlinear Schrödinger equations

The cubic focusing and defocusing Schrödinger equations in one dimension admit periodic wave solutions given by snoidal, cnoidal, and dnoidal Jacobi elliptic functions. We examine the stability of these solutions, and among other things prove the spectral stability of the cnoidal waves (in a certain parameter range) with respect to same-period perturbations. This is done via variational and spectral analysis, while as much as possible avoiding the use of complete integrability. This is joint work with Stefan Le Coz and Tai-Peng Tsai.

THEODORE KOLOKOLNIKOV,
[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 276]
A novel PDE model of aggregation formation in bacterial colonies

We study pattern formation in a model of cyanobacteria motion recently proposed by Galante, Wisen Bhaya and Levy. By taking a continuum limit of their model, we derive a novel fourth-order nonlinear parabolic PDE. Using this PDE, we derive the instability thresholds for the onset of pattern formation. We then compute analytically the spatial profiles of the steady state aggregation density. These profiles are shown to be the form $sech^p$ where the exponent p is related to the switching rates and other parameters of the model. Full numerical simulations give a favorable comparison between the continuum and the underlying discrete system, and show that the aggregation profiles are stable above the critical threshold.

M. NIKSIRAT, University of Toronto
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 276]
On the existence of periodic solutions to nonlinear evolution equations

Let $\Omega \subset \mathbb{R}^n$ be an open bounded set and $T > 0$. We are concern with the existence of periodic solutions to the evolution equation

$$\begin{cases} \partial_t u + f(t, x, D^{\leq 2}u) = 0 \\ u(0) = u(T) \end{cases},$$

where $x \in \Omega$ and f is T-periodic with respect to t and is uniformly elliptic. This means

$$f(t+T, x, D^{\leq 2}u) = f(t, x, D^{\leq 2}u),$$

and

$$\sum_{|\alpha|=2} f_\alpha(t, x, D^{\leq 2}u)\xi^\alpha \geqq \theta|\xi|^2$$

for some $\theta > 0$ and any $\xi \in \mathbb{R}^n - \{0\}$. Letting $u : [0, T] \to X$ where $X = H^{2+n_0}(\Omega) \cap H_0^1(\Omega)$ for $n_0 = \left[\frac{n}{2}\right] + 1$, we generalize the Skrypnik's degree for fully nonlinear elliptic maps of the form $f(x, D^{\leq 2}u)$ to one-parameter family of maps of the form $f(t, x, D^{\leq 2}u)$ and then use the Browder's degree for maps of the form $A = T + \varphi$, where T is a maximal monotone map and φ is a $(S)_+$ map to establish conditions for the existence of a periodic solution to fully nonlinear evolution equations.

CHUNHUA OU, Memorial University

[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 276]

Periodic steady-state solutions to the liquid film flowing model: existence and stability

In this talk, we investigate the dynamics of a liquid film flowing over a periodic wavy wall. This study is based on a long-wave model that is valid at near-critical Reynolds number. For the periodic wall surface, we construct an iteration scheme in terms of an integral form of the original steady-state problem. The uniform convergence of the scheme is proved so that we can derive the existence, uniqueness as well as the asymptotic formula of the periodic solutions. These results can also be obtained by the method of abstract contraction mapping in a particular functional space. Using the Floquet-Bloch theory, we establish several analytic results on the stability/instability of the periodic steady-state solutions in a weighted functional space.

BRENDAN PASS, University of Alberta

[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 276]

Multi - to one - dimensional transportation

I will discuss joint work with Pierre-Andre Chiappori and Robert McCann on the Monge-Kantorovich problem of transporting a probability measure on $\mathbf{R}^n$ to another on the real line. We introduce a nestededness criterion relating the cost to the marginals, under which it is possible to solve this problem uniquely (and essentially explicitly), by constructing an optimal map one level set at a time. I plan to discuss examples for which the nestedness condition holds, as well as some for which it fails; some of these examples arise from a matching problem in economics which originally motivated our work. If time permits, I will also briefly discuss how level set dynamics can be used to develop a local regularity theory in the nested case.

CRISTIAN RIOS, University of Calgary

[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 276]

Harnack's estimates for fractional powers of non-symmetric second order operators

We build on the Caffarelli-Silvestre treatment of fractional powers of elliptic operators and extend it to non-symmetric operators on Banach spaces. To illustrate the reach of this more general extension theorem we obtain a-priory boundedness of solutions and Harnack's estimates for solutions of fractional powers of weighted elliptic operators, subelliptic operators, and operators in nondivergence form.

DIMITRIOS ROXANAS, University of British Columbia

[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 276]

Global solutions of a focusing energy-critical heat equation

We study the focusing energy-critical nonlinear heat equation $u_t - \Delta u - |u|^2 u = 0$, in $\mathbb{R}^4$. We prove that solutions emanating from initial data with energy and kinetic energy below those of the stationary solution are global and decay to zero. We show that global solutions dissipate to zero building on a refined small data theory and L^2-dissipation. To rule out the possibility of finite-time blow-up we argue by resorting to the "concentration-compactness plus rigidity" approach of Kenig and Merle for dispersive equations. We exploit the dissipation but our proof does not rely on maximum/comparison principles. The above result extends to all dimensions $d \geq 3$. This is joint work with Stephen Gustafson.

ERIC SAWYER, McMaster

[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 276]

IHSAN TOPALOGLU, McMaster University
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 276]
Small volume fraction limit of a nonlocal isoperimetric problem with confinement

The nonlocal isoperimetric problem that I will consider in this talk arises as the sharp interface limit of Ohta-Kawasaki functionals introduced to model microphase separation of diblock copolymers. In our problem there is an additional term which penalizes one phase hence forces the other block copolymer phase into a confinement region. Using Γ-convergence we will identify the first- and second-order effective energies in the asymptotic limit of small volume fraction and strong confinement. Depending on the choice of penalization we will show that the second-order limit of these energies will be given by attractive-repulsive nonlocal interaction energies of weighted Dirac-delta functions corresponding to the concentration of mass into point particles. This is a joint work with S. Alama, L. Bronsard and R. Choksi.

JEROME VETOIS, McGill University
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 276]
Clustering solutions for smooth perturbations of a critical elliptic equation in low dimensions

I will discuss the question of existence of positive solutions with multiple clustering peaks for smooth perturbations of a critical elliptic equation on a closed manifold. I will present an existence result of such solutions for the Lin-Ni equation in dimensions four and five on a manifold with negative scalar curvature. This is a joint work with Pierre-Damien Thizy (University of Cergy-Pontoise).

ERIC WOOLGAR, University of Alberta
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 276]
Ricci flow of partially even metrics

Both the general variational theory and the Ricci flow theory of compact Riemannian manifolds have been widely studied. The noncompact case, however, raises many open issues. A nice place to start is with the conformally compactifiable, asymptotically hyperbolic metrics. These have enough structure at infinity to permit the definition of renormalized curvature integrals, which may then admit a variational theory and may also provide possible monotonic quantities for Ricci flow. We consider the "partially even" metrics. These are conformally compactifiable and asymptotically hyperbolic, and admit a Fefferman-Graham expansion whose first few terms are even. If such a metric also obeys a certain trace condition, it is volume renormalizable. We show that normalized Ricci flow preserves the partially even and volume renormalizable properties, and we obtain a formula for the change in renormalized volume along the flow. This is joint work with Eric Bahuaud and Rafe Mazzeo.

XINWEI YU, University of Alberta
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 276]
Regularity criteria of 3D Navier-Stokes Equations involving the pressure term

In this talk we will present some new regularity criteria for the 3D Navier-Stokes equations. This new criteria involve combinations of the pressure and the velocity. They improve the classical Prodi-Serrin conditions. This is joint work with Prof. Chuong V. Tran of University of St. Andrews, Scotland.

Rational Points, Rational Curves, and Positivity of Projective Varieties / Points rationnels, courbes rationnelles et positivité des varietés projectives

Org: Xi Chen (Alberta) and/et **Nathan Grieve** (UNB)

Schedule/Horaire **Room/Salle: Education Building 213**

Saturday June 25	**samedi 25 juin**
8:30 - 9:15	James Lewis, *The Business of Height Pairings*
9:15 - 10:00	Dingxin Zhang, *Degeneration of slopes*
15:30 - 16:15	Roya Beheshti, *Spaces of rational curves on Fano hypersurfaces*
16:15 - 17:00	David McKinnon, *Rational points and rational curves*

Sunday June 26	**dimanche 26 juin**
8:30 - 9:15	Chuck Doran, *Picard-Fuchs Equations and Shimura Subvarieties*
9:15 - 10:00	Jennifer Park, *A heuristic for boundedness of elliptic curves*
10:30 - 11:00	Nathan Grieve, *Approximating rational points of varieties over function fields*
11:00 - 11:30	Xi Chen, *Log rational curves on log K3 surfaces*

Abstracts/Résumés

ROYA BEHESHTI, Washington University
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 213]
Spaces of rational curves on Fano hypersurfaces

I will discuss the geometry of moduli spaces of rational curves on Fano hypersurfaces focusing on some questions on dimension, irreducibility, and the Kodaira dimension of these spaces.

XI CHEN, University of Alberta
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 213]
Log rational curves on log K3 surfaces

We prove that there are infinitely many log rational curves on a genuine log K3 surface if and only if it has a log K3 Iitaka model. This is a joint work with Yi Zhu.

CHUCK DORAN, University of Alberta and University of Maryland
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 213]
Picard-Fuchs Equations and Shimura Subvarieties

We explain, both abstractly and through concrete examples, how the problem of detecting families of lattice-polarized K3 surfaces with higher-than-normal Picard rank can be recast in differential algebraic terms. Starting from the uniformizing differential equation for a moduli space, we provide a complete differential algebraic characterization of the totally geodesic divisors. Rational solutions to these differential equations then correspond to rational divisors on which the Picard rank increases by one. This is joint work with Andrew Harder, building on special cases previously studied with Adrian Clingher, Jacob Lewis, Hossein Movosati, and Ursula Whitcher.

NATHAN GRIEVE, UNB
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 213]
Approximating rational points of varieties over function fields

I will discuss recent results, motivated by work of McKinnon-Roth in the number field setting, which pertain to approximation constants for points of projective varieties over function fields. My intent is to explain how the subspace theorem and measures of local positivity are used in the proof of these results and also to describe the relation to rational curves.

JAMES LEWIS, University of Albeta.ca
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 213]
The Business of Height Pairings

In algebraic geometry there is the notion of a height pairing of algebraic cycles, which lies at the confluence of arithmetic, Hodge theory and topology. After explaining a motivating example situation, we introduce new directions in this subject. (This is joint work with Souvik Goswami, and will appear in a special volume in honour of Steven Zucker's 65th birthday.)

DAVID MCKINNON, University of Waterloo
[Saturday June 25 / samedi 25 juin, 16:15 – Education Building 213]
Rational points and rational curves

Rational points should accumulate on rational curves. In this talk, I'll describe some ways in which humanity (in the persons of myself and Mike Roth of Queen's University) have found reasons to believe in this moral, and in some cases even taken the conditional out of that sentence.

JENNIFER PARK, University of Michigan
[Sunday June 26 / dimanche 26 juin, 9:15 – Education Building 213]
A heuristic for boundedness of elliptic curves

I will discuss a heuristic that predicts that the ranks of all but finitely many elliptic curves defined over $\mathbb{Q}$ are bounded above by 21. This is joint work with Bjorn Poonen, John Voight, and Melanie Matchett Wood.

DINGXIN ZHANG, Stony Brook University
[Saturday June 25 / samedi 25 juin, 9:15 – Education Building 213]
Degeneration of slopes

Given a smooth family of algebraic varieties over a perfect field of characteristic p, Grothendieck proves that the Newton polygons of their cohomologies jump up under specialization. I shall present a result that generalizes this phenomenon when the family acquires singularities. This could be thought as an equal characteristic version of a theorem of Berthelot, Esnault and Rülling.

Representation Theory / Théorie des représentations

Org: Thomas Creutzig and/et **Nicolas Guay** (Alberta)

Schedule/Horaire **Room/Salle: Education Building 158**

Saturday June 25	**samedi 25 juin**
8:30 - 9:00	Yun Gao, *Quantized GIM algebras*
9:00 - 9:30	Mikhail Kotchetov, *Graded-simple algebras and modules via the loop construction*
9:30 - 10:00	Allen Herman, *Unitary groups over p-adic integers - the ramified case*
15:30 - 16:00	Monica Nevins, *On archetypes and an inertial Langlands correspondence*
16:00 - 16:30	Curtis Wendlandt, *Finite-dimensional representations of twisted Yangians of types B,C and D*
16:30 - 17:00	Gerald Cliff, *PBW, canonical, and crystal bases for quantized enveloping algebras*
17:00 - 17:30	Murray Bremner, *Classification of regular parametrized one-relation operads*

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Andrew Linshaw
9:00 - 9:30	Kaiming Zhao, *Simple W_n^+-modules from Weyl modules and gl_n-modules*
9:30 - 10:00	Matthew Rupert, *Logarithmic Hopf Link Invariants for $\overline{U}_q^H(\mathfrak{sl}(2))$*
10:30 - 11:00	Vincent X. Genest, *Multifold tensor product modules of $su_q(1,1)$, trigonometric superintegable systems, and multivariate q-special functions*
11:00 - 11:30	Yvan Saint-Aubin, *The category of Temperley-Lieb algebras and their fusion product*
15:30 - 16:00	Clifton Cunningham, *An example of Vogan's geometric description of Arthur packets for p-adic groups*
16:00 - 16:30	Luc Vinet, *A Superintegrable Model on the 3-sphere with Reflections and the Rank 2 Bannai-Ito Algebra*
16:30 - 17:00	Athena Nguyen
17:00 - 17:30	Michael Lau, *Harish-Chandra modules for current algebras*

Abstracts/Résumés

MURRAY BREMNER, University of Saskatchewan
[Saturday June 25 / samedi 25 juin, 17:00 – Education Building 158]
Classification of regular parametrized one-relation operads

Jean-Louis Loday introduced a class of symmetric operads generated by one bilinear operation subject to one relation making each left-normed product of three elements equal to a linear combination of right-normed products:

$$(a_1a_2)a_3 = \sum_{\sigma\in S_3} x_\sigma a_{\sigma(1)}(a_{\sigma(2)}a_{\sigma(3)});$$

such an operad is called a parametrized one-relation operad. For a particular choice of parameters $\{x_\sigma\}$, this operad is said to be regular if each of its components is the regular representation of the symmetric group; equivalently, the corresponding

free algebra on a vector space V is, as a graded vector space, isomorphic to the tensor algebra of V. We classify, over an algebraically closed field of characteristic zero, all regular parametrized one-relation operads. In fact, we prove that each such operad is isomorphic to one of the following five operads: the left-nilpotent operad defined by the identity $((a_1a_2)a_3) = 0$, the associative operad, the Leibniz operad, the dual Leibniz (Zinbiel) operad, and the Poisson operad. Our computational methods combine linear algebra over polynomial rings, representation theory of the symmetric group, and Gröbner bases for determinantal ideals and their radicals.

GERALD CLIFF, University of Alberta
[Saturday June 25 / samedi 25 juin, 16:30 – Education Building 158]
PBW, canonical, and crystal bases for quantized enveloping algebras

Lusztig has defined PBW bases P for the minus part of the quantized enveloping algebra of a semi-simple complex Lie algebra. It is known that these PBW bases have a crystal structure in the sense of Kashiwara, but it is not known, in general, how to define Kashiwara's crystal operators on P. We show how this can be done for types A, B, C, and D, using tableaux of Kashiwara-Nakashima. (In type A, these are the usual semi-standard Young tableaux.) This is new for types B and C.

CLIFTON CUNNINGHAM, University of Calgary
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 158]
An example of Vogan's geometric description of Arthur packets for p-adic groups

In 1992, David Vogan conjectured how one might use techniques from microlocal geometry to study Arthur packets of irreducible admissible representations of connected reductive groups over local fields. Shortly after, Adams, Barbasch and Vogan proved this conjecture for reductive groups over Real numbers. By contrast, Vogan's conjecture remains open for reductive groups over p-adic fields. In this talk we give a precise statement of Vogan's conjecture for Arthur packets of admissible representations of p-adic groups and the stable distributions attached to them by Arthur's work; this version of the conjecture makes no mention of microlocal geometry. Then we give an example of this conjecture, involving 15 representations of p-adic $\mathrm{SO}(7)$, both split and anisotropic forms, and confirm the conjecture in this case. This is joint work with Andrew Fiori, James Mracek, Ahmed Moussaoui and Bin Xu.

YUN GAO, York University
[Saturday June 25 / samedi 25 juin, 8:30 – Education Building 158]
Quantized GIM algebras

Generalized intersection matrix Lie algebra was introduced by Slodowy. It is known that a GIM Lie algebra is a fixed point of an involution of Kac-Moody Lie algebra for a double-sized generalized Cartan Matrix. We define a quantum version for simply-laced GIM Lie algebras and obtain a quantum analog of the above result.

VINCENT X. GENEST, Massachusetts Institute of Technology
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 158]
Multifold tensor product modules of $su_q(1,1)$, trigonometric superintegable systems, and multivariate q-special functions

In this talk, I will explain how to construct separated wavefunctions for q-analogs of second-order superintegrable systems in any dimension. The construction is based on the decomposition of multifold tensor product modules of the quantum algebra $su_q(1,1)$ in irreducible components using multivariate q-special functions of q-Hahn or q-Jacobi type as generalized recoupling coefficients.

ALLEN HERMAN, University of Regina
[Saturday June 25 / samedi 25 juin, 9:30 – Education Building 158]
Unitary groups over p-adic integers - the ramified case

When L is a quadratic extension of a p-adic number field K, the Galois automorphism of L acts nontrivially on the ring of integers $\mathcal{O}_L$. Composing with the transpose induces an involution $*$ on $M_n(\mathcal{O}_L)$. The resulting unitary group $U_n(\mathcal{O}_L) = \{X : X^{-1} = X^*\}$ satisfies the congruence subgroup property, which means any continuous finite-dimensional representation factors through a congruence subgroup. This reduces the study of representations of these groups to the study of representations of

unitary groups over the finite local rings $R = \mathcal{O}/\mathcal{P}^N$. Of particular interest is the description of irreducible constituents of the Weil representation of $U_n(R)$ in this situation. Previous work of Gow and Szechtman treated the case where p is odd and L/K is unramified. Recently we have calculated the orders of these unitary groups $U_n(R)$ when p is odd and L/K is ramified. We have determined irreducible constituents of the Weil representation and calculated the degrees of these characters when the level N is even, using tools from character theory and hermitian geometry over local rings. This is joint work with Fernando Szechtman, James Cruikshank, and Rachael Quinlan.

MIKHAIL KOTCHETOV, Memorial University
[Saturday June 25 / samedi 25 juin, 9:00 – Education Building 158]
Graded-simple algebras and modules via the loop construction

The construction of (twisted) loop and multiloop algebras plays an important role in the theory of infinite-dimensional Lie algebras. Given a grading by $\mathbb{Z}/m\mathbb{Z}$ on a semisimple Lie algebra, the loop construction produces a $\mathbb{Z}$-graded infinite-dimensional Lie algebra.

This was generalized by Allison, Berman, Faulkner and Pianzola to arbitrary nonassociative algebras and arbitrary quotients of abelian groups. In view of their results, the recent classification of gradings by arbitrary abelian groups on finite-dimensional simple Lie algebras (over an algebraically closed field of charactersitic zero) yields a classification of finite-dimensional graded-simple Lie algebras.

Mazorchuk and Zhao have recently applied the loop construction to modules. In this talk, we will show how this leads to a classification of finite-dimensional graded-simple modules over simple Lie algebras with a grading. This is joint work with Alberto Elduque.

MICHAEL LAU, Université Laval
[Sunday June 26 / dimanche 26 juin, 17:00 – Education Building 158]
Harish-Chandra modules for current algebras

Current algebras are Lie algebras of regular maps from an affine variety to a finite-dimensional simple Lie algebra. We will discuss the classification of simple weight modules (with finite dimensional weight spaces) for current algebras.

ANDREW LINSHAW, University of Denver
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 158]

MONICA NEVINS, University of Ottawa
[Saturday June 25 / samedi 25 juin, 15:30 – Education Building 158]
On archetypes and an inertial Langlands correspondence

We summarize recent work by Henniart, Latham, Nadimpalli and others towards an inertial local Langlands correspondence, and present some preliminary new results. A key step is to replace so-called types, which often encode construction data for representations but are defined on a variety of compact open subgroups, with the closely-related notion of an archetype, which lives on a maximal compact open subgroup. There is a growing body of results relating archetypes to the restrictions to inertia of corresponding L-parameters in an nice way.

ATHENA NGUYEN, UBC
[Sunday June 26 / dimanche 26 juin, 16:30 – Education Building 158]

MATTHEW RUPERT, -University of Alberta
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 158]
Logarithmic Hopf Link Invariants for $\overline{U}_q^H(\mathfrak{sl}(2))$

Little is known about Vertex Operator Algebras (VOAs) which are neither C_2-cofinite nor rational, and most of the work on such VOAs has been focused on specific examples such as the Singlet. It is thought that the representation categories for the Singlet and the unrolled restricted quantum group associated to $\mathfrak{sl}(2)$, $\overline{U}_q^H(\mathfrak{sl}(2))$, are closely related. In this talk I will provide an overview of the relationships between these categories and present results on the representation category of $\overline{U}_q^H(\mathfrak{sl}(2))$. In particular, I will demonstrate an efficient method for computing open Hopf links and Alexander invariants colored with projective modules via families of deformable modules.

YVAN SAINT-AUBIN, Université de Montréal
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 158]
The category of Temperley-Lieb algebras and their fusion product

The Temperley-Lieb algebras $\mathrm{TL}_n(\beta)$ appear in several chapters of mathematics and physics. In the latter, one particular element of a $\mathrm{TL}_n(\beta)$ captures the Boltzmann weights of several statistical models. The family of algebras $\mathrm{TL}_n(\beta), n \geq 1$, was cast into a category by Graham and Lehrer (1998). Independently Read and Saleur (2007) introduced a fusion product on the modules over these algebras, that is an operation (a functor) that maps two modules into a third one. These modules are in general over distinct algebras of the Temperley-Lieb family.

We show that the category of the Temperley-Lieb algebras is braided and that this braiding can be extended naturally to a category of modules over the family for the product introduced by Read and Saleur.

Joint work with J. Belletête.

LUC VINET, CRM, Université de Montréal
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 158]
A Superintegrable Model on the 3-sphere with Reflections and the Rank 2 Bannai-Ito Algebra

I shall present a quantum superintegrable model on the 3-sphere with reflections. Its symmetry algebra will be identified as the rank-two Bannai-Ito algebra. It will shown that the Hamiltonian can be constructed from the tensor product of four irreducible representations of the superalgebra osp(1,2) and that its superintegrability is naturally understood in that setting. The exact separated solutions will be obtained through the Fisher decomposition and a Cauchy-Kovalevskaia extension.

Based on work done in collaboration with H. De Bie (Ghent), V. X. Genest (MIT), J.-M. Lemay (CRM).

CURTIS WENDLANDT, University of Alberta
[Saturday June 25 / samedi 25 juin, 16:00 – Education Building 158]
Finite-dimensional representations of twisted Yangians of types B,C and D

Recently, a new family of twisted Yangians have been introduced which are in one-to-one correspondence with symmetric pairs of types B, C and D. Similar to the untwisted Yangians, these new quantum algebras possess many elegant properties. For instance, it is possible to study their representation theory using a highest weight approach. The goal of this talk is to present some of the first results in that direction, with emphasis on the finite-dimensional irreducible modules. In particular, we will use the notion of a highest weight module to obtain a classification of finite-dimensional irreducible modules for some of these new twisted Yangians. This is joint work with N. Guay and V. Regelskis.

KAIMING ZHAO, Wilfrid Laurier University
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 158]
Simple W_n^+-modules from Weyl modules and gl_n-modules

For a simple module P over the Weyl algebra K_n^+ and a simple module M over gl_n. Using Shen's monomorphism we make $P \otimes M$ into a module over the Witt algebra W_n^+. I will give the necessary and sufficient conditions for the W_n^+-module $P \otimes M$ to be simple.

Special Session on Combinatorial Games to celebrate Richard K. Guy's 100th birthday / Session spéciale sur les jeux combinatoires pour célébrer le 100e anniversaire de Richard K. Guy

Org: Richard Nowakowski (Dalhousie)

Schedule/Horaire **Room/Salle: Education Building 303**

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Richard Nowakowski, *Absolute Game Theory: a new context for additive combinatorial games*
9:00 - 9:30	Rebecca Milley, *Inverses & Reversibility: Open Problems in Partizan Misere Games*
9:30 - 10:00	Melissa Huggan, *Conjoined Games: Go-Cut and Sno-Go*
10:30 - 11:00	Aviezri Fraenkel, *Games Derived From A Generalized Thue-Morse Word*
11:00 - 11:30	Svenja Hunteman, *Some Game Values of Strong Placement Games*
15:30 - 16:00	Paul Ottaway

Abstracts/Résumés

AVIEZRI FRAENKEL, Weizmann Institute of Science
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 303]
Games Derived From A Generalized Thue-Morse Word

For fusing combinatorial game theory with combinatorics on words, we begin with some relevant background on words and automata theory, followed by devising and analyzing a triple of games derived from a generalization of the Thue-Morse word. Joint with Michel Rigo.

MELISSA HUGGAN, Dalhousie University
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 303]
Conjoined Games: Go-Cut and Sno-Go

Let $\mathcal{F}$ and $\mathcal{H}$ be two impartial rulesets. We introduce the *conjoined ruleset* $(\mathcal{F} \blacktriangleright \mathcal{H})$ in which the game is played under the $\mathcal{F}$ ruleset and then, when play is no longer possible, to continue under the $\mathcal{H}$ ruleset. The games of Go-Cut and Sno-Go on a path are considered. We give nim-values for positions at the start of Phase 2 for Go-Cut and for Sno-Go we determine the winner.

SVENJA HUNTEMAN, Dalhousie University
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 303]
Some Game Values of Strong Placement Games

Strong placement games are a class of combinatorial games that include for example Snort, NoGo, Domineering, and Arc Kayles. We are interested in which values games in this class can take on under normal play. This work takes advantage of the property that strong placement games are in a one-to-one correspondence with simplicial complexes whose vertex sets are bipartitioned. Using this connection, one can show that all numbers are possible, many switches, and several tinies, among others.

REBECCA MILLEY, Grenfell Campus, Memorial University of Newfoundland
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 303]
Inverses & Reversibility: Open Problems in Partizan Misere Games

Much progress has been made in misere game theory using the technique of *restricted misere play*, where games can be considered equivalent inside a restricted set of games without being equal in general. Recent research has found instances of two particularly interesting properties among restricted misere games: (1) a game can have an additive inverse that is not its negative, and (2) a position can be reversible through an *end* (a game with Left but not Right options, or vice versa). These properties are not possible in normal play and general misere play, respectively. This talk will discuss open problems of inverses and reversibility in a survey of partizan misere game theory (joint work with Gabriel Renault).

RICHARD NOWAKOWSKI, Dalhousie University
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 303]
Absolute Game Theory: a new context for additive combinatorial games

Several different subclasses of games, for example, Normal, Misere, Dicot Misere, Guaranteed Scoring, Dicot Scoring, have similar algebraic structure. We show that there is a set of underlying properties that give rise to these structures and, moreover, any such subset will form a combinatorial game category. Joint work with Urban Larsson and Carlos Santos.

PAUL OTTAWAY, Capilano
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 303]

Student Research Presentations / Présentations de recherche des étudiants

Org: Muhammad Khan (Calgary) and/et **Kyle MacDonald** (McMaster)

Schedule/Horaire **Room/Salle: Education Building 206**

Friday June 24	**vendredi 24 juin**
13:00 - 13:30	Hatef Dastour, *A computational method for solving an inverse heat conduction problem*
13:30 - 14:00	Raed Mara'Beh, *Localized Spot Patterns for the Brusselator Reaction-Diffusion System*
14:00 - 14:30	Zijia Wang, *Modelling of Variance and Volatility Swaps with Stochastic Volatility and Jumps*
15:00 - 15:30	Aram Dermenjian, *Facial Weak Order for finite Coxeter groups*
15:30 - 16:00	Chimaobi Amadi, *Generation of 7x7 Calcrostic Puzzles and Rational Solution of Highly Underdetermined Polynomial Systems*
16:00 - 16:30	Lirong Yang, *Generalization of two notions in group theory-associativity and order*

Abstracts/Résumés

CHIMAOBI AMADI, Brock University
[Friday June 24 / vendredi 24 juin, 15:30 – Education Building 206]
Generation of 7x7 Calcrostic Puzzles and Rational Solution of Highly Underdetermined Polynomial Systems

This talk is on the generation of new types of mathematical 'calcrostic' puzzles. In these puzzles the task is to determine for each letter the corresponding digit that the letter represents such that a number of conditions arranged in the form of a crossword problem are satisfied. Earlier versions of these puzzles were used in Caribou Mathematics Contests with large Canadian and international participation.

Through our work we are able to generate larger calcrostics, now of size 5x5 and 7x7 instead of 3x3, more complicated ones, now involving rational numbers rather than integers, and puzzles that require many more conditions to be satisfied through extra diagonal relations.

Apart from many new procedures that had to be written for handling these new types of puzzles, the key problem was that much larger systems of under-determined polynomial equations needed to be solved with computer algebra. We developed a method of computing special solutions of highly under-determined and highly non-linear, polynomial equations. The new technique was implemented and merged into the computer algebra package CRACK. It was successfully used for the generation of all types of new calcrostic puzzles.

HATEF DASTOUR, The University of Calgary
[Friday June 24 / vendredi 24 juin, 13:00 – Education Building 206]
A computational method for solving an inverse heat conduction problem

In this study, a one-dimensional inverse heat conduction problem with unknown nonlinear boundary conditions is investigated. Nonlinear boundary conditions are imposed involving both the flux and the temperature. The heat transfer coefficient depends

on the boundary temperature and the dependence has a complicated or unknown structure. A numerical algorithm is generated, based on a space marching scheme and the mollification method, and its stability and convergence are analyzed. Two numerical examples are tested to illustrate the efficiency of the proposed algorithm.

We will discuss a poset structure that extends the weak order on a finite Coxeter group W to the set of all faces of the permutahedron of W. We call this order the facial weak order. We first provide two characterizations of this poset: a local one, which was first studied by Krob, Latapy, Novelli, Phan, and Schwer in the case of symmetric groups, and a global one, that generalizes the notion of inversion sets of roots. These characterizations are the keys to show that the facial weak order is a lattice, generalizing a well-known result of A. Björner for the classical weak order. This is joint work with Christophe Hohlweg and Vincent Pilaud.

RAED MARA'BEH, University of Saskatchewan
[Friday June 24 / vendredi 24 juin, 13:30 – Education Building 206]
Localized Spot Patterns for the Brusselator Reaction-Diffusion System

The Brusselator reaction-diffusion model characterizes dynamical processes of some reaction-diffusion systems in chemistry, physics, biology, and geology. On the sphere, the solutions of the Brusselator system center on a discrete set of points. In this talk, we study the system of differential-algebraic equations (DAEs) that describes the slow dynamics of localized spot patterns for the Brusselator model on the surface of a unit sphere. The DAE system is solved numerically using Matlab's ode15s function. The relationship between the equilibria of the DAE system and the set of elliptic Fekete points is studied. Precisely, solutions of the DAE system are obtained from solving the elliptic Fekete optimization problem. The optimization problem is solved using the particle swarm optimization method. It is verified that for N = 2, 3,...,8 spots, the equilibrium spot configurations of the DAE system starting from a set of random initial points are elliptic Fekete points.

ZIJIA WANG, University of Calgary
[Friday June 24 / vendredi 24 juin, 14:00 – Education Building 206]
Modelling of Variance and Volatility Swaps with Stochastic Volatility and Jumps

In this presentation, we will introduce the financial derivatives variance and volatility swaps. A general analytic approach for pricing discretely sampled variance and volatility swaps under Heston stochastic volatility model will be presented. We investigate the effect of asset price jumps on fair swaps strikes. The closed form pricing formula for variance swap under exponential Lévy Process will also be discussed.

LIRONG YANG, University of Waterloo
[Friday June 24 / vendredi 24 juin, 16:00 – Education Building 206]
Generalization of two notions in group theory-associativity and order

In this talk, we generalize two group-theoretic ideas as follows.

i) We formalize and prove "the most general setting" to define associativity of a binary function and generalized associativity, i.e. "inserting parentheses in any manner".

ii) By definition, the order of an element is either a positive integer or infinite. Using transfinite recursion, we generalize the notion to the class of ordinals for topological groups. Arithmetical and group-theoretic properties of such generalization are studied. We also discuss examples that lead to further questions.

Theoretical and numerical methods in nonlinear analysis with real-world applications / Méthodes théoriques et numériques en analyse non linéaire avec des applications dans le monde réel

Org: Fabrice Colin and/et **Albert Nina Sandjo** (Laurentian)

Schedule/Horaire **Rooms/Salles: Educaiton Building 206, Education Building 206**

Sunday June 26	**dimanche 26 juin**
8:30 - 9:00	Arno Berger, Education Building 206, *Digit distributions in non-linear difference equations*
9:00 - 9:30	Jean-Marc Belley, Education Building 206, *Anti-periodic solutions of Abel equations with state dependent discontinuities*
9:30 - 10:00	Marlène Frigon, Education Building 206, *Existence results for initial value problems of first-order systems of Stieltjes differential equations*
10:30 - 11:00	Rahma Guen, Education Building 206, *Some averaging results for ordinary differential inclusions*
11:00 - 11:30	Cyril Joël Batkam, Education Building 206
15:30 - 16:00	Abdellatif Serghini, Education Building 206
16:00 - 16:30	Gerda de Vries, Education Building 206, *Formation of Animal Groups : The Importance of Communication*
16:30 - 17:00	Juncheng Wei, Educaiton Building 206

Abstracts/Résumés

CYRIL JOËL BATKAM, HEC Montréal
[Sunday June 26 / dimanche 26 juin, 11:00 – Education Building 206]

JEAN-MARC BELLEY, Université de Sherbrooke
[Sunday June 26 / dimanche 26 juin, 9:00 – Education Building 206]
Anti-periodic solutions of Abel equations with state dependent discontinuities

Given $T > 0$, we study Abel's generalized equation $\theta' = f_0 + \sum_{j\in\mathbb{N}} f_j \theta^j$ for θ and θ' real functions on $[0,T]$ subject to given state dependent discontinuities and each f_j a real function of bounded variation for which $f_j(0) = (-1)^{j+1} f_j(T)$. Under appropriate conditions, this equation is shown to admit a unique solution of bounded variation on $[0,T]$ which is T-anti-periodic in the sense that $\theta(0) = -\theta(T)$. The contraction principle yields a bound for the rate of uniform convergence to the solution of a sequence of iterates.

ARNO BERGER, University of Alberta
[Sunday June 26 / dimanche 26 juin, 8:30 – Education Building 206]
Digit distributions in non-linear difference equations

The statistical behaviour of numerical signals recorded from a linear dynamical system is quite simple: Generically, any such signal shows one and only one logarithmic distribution of significant digits a.k.a. Benford's Law. For non-linear systems, the situation naturally is far less clear-cut. Even when the dynamics in question is trivial, determining typical digit distributions may nevertheless be delicate. The talk will discuss a few recent results and (counter-)examples in this regard.

GERDA DE VRIES, University of Alberta
[Sunday June 26 / dimanche 26 juin, 16:00 – Education Building 206]
Formation of Animal Groups : The Importance of Communication

We investigate the formation and movement of self-organizing collectives of individuals in homogeneous environments. We review a hyperbolic system of conservation laws based on the assumption that the interactions governing movement depend not only on distance between individuals, but also on whether neighbours move towards or away from the reference individual. The inclusion of direction-dependent communication mechanisms significantly enriches the model behavior; the model exhibits classical patterns such as stationary pulses and traveling trains, but also novel patterns such as zigzag pulses, breathers, and feathers. The same enrichment of model behavior is observed when we include direction-dependent communication mechanisms in individual-based models.

MARLÈNE FRIGON, Université de Montréal
[Sunday June 26 / dimanche 26 juin, 9:30 – Education Building 206]
Existence results for initial value problems of first-order systems of Stieltjes differential equations

We present the basic theory of existence and uniqueness of solutions for systems of differential equations with the usual derivative replaced by a Stieltjes derivative. This derivative, called g-derivative, was introduced by Lopez Pouso and Rodriguez. The problems that we consider contain as particular cases dynamic equations on time scales and impulsive ordinary differential equations. Our results were obtained in collaboration with Lopez Pouso.

RAHMA GUEN, Université de Sherbrooke
[Sunday June 26 / dimanche 26 juin, 10:30 – Education Building 206]
Some averaging results for ordinary differential inclusions

The averaging method was studied for differential inclusions by many authors using different and rather restrictive conditions on the regularity of their right- hand sides. We consider ordinary differential inclusions of the form

$$\dot{x}(t) \in F\left(\frac{t}{\varepsilon}, x(t)\right) \tag{1}$$

where $\varepsilon > 0$ denotes the small perturbation parameter, the time variable $t \in [0, L]$ and F is a multifunction with values that are nonempty compact convex subsets of $\mathbb{R}^d$. We state and discuss some averaging results for these inclusions. Our results are proved under weaker conditions on the regularity of F than found in the literature.

ABDELLATIF SERGHINI, Laurentian
[Sunday June 26 / dimanche 26 juin, 15:30 – Education Building 206]

JUNCHENG WEI, UBC
[Sunday June 26 / dimanche 26 juin, 16:30 – Educaiton Building 206]

Contributed Papers / Communications libres

Abstract/Résumé

ROSTAM SABETI, Olivet College

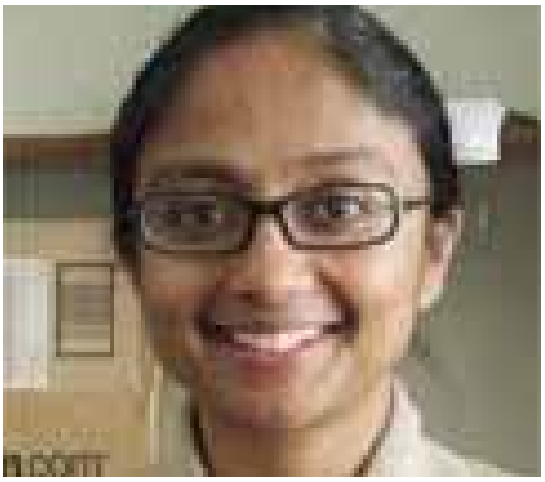
1-variable Descartes' Rule of signs and ideal of symmetric polynomials

Given a sign pattern for the coefficients of an unknown polynomial $p(x)$ in $\mathbb{C}[x]$ of degree n and consider the coefficients as symmetric polynomials in $\mathbb{C}[s_1, \cdots, s_n]$, we prove that at the rational roots of $p(x)$ proposed by Anderson, Jackson and Sitharam the rank of the associated symmetric system is either one or two.

Notes

Krieger-Nelson Prize

Malabika Pramanik



Malabika Pramanik's research spans a range of areas of mathematical analysis. Referees commented that Pramanik "is one of the leading young mathematicians worldwide doing research in harmonic analysis and its applications" and "is one of the most talented analysts of her generation". While her work is deeply and solidly rooted in classical harmonic analysis, it has also made an impact in such diverse areas of mathematics as inverse problems, geometric measure theory, differential geometry and resolution of singularities in complex analysis. She has worked on an impressive variety of deep and difficult questions, from well known classical open problems to setting out new paths in emerging areas.

Pramanik's early work focused on classical problems in oscillatory integrals, maximal and averaging operators, and local smoothing estimates with applications to dispersive partial differential equations. This is a beautiful area of mathematics, intertwining hard analysis with ingenious geometric

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Prix Krieger-Nelson

Malabika Pramanik

La recherche de Malabika Pramanik s'étend à divers domaines de l'analyse mathématique. Selon les arbitres, Mme Pramanik est « l'une des plus illustres jeunes mathématiciennes au monde réalisant de la recherche en analyse harmonique et sur ses applications » et est « une des analystes les plus talentueuses de sa génération ». Même si son travail est profondément et solidement fondé sur l'analyse harmonique traditionnelle, il a aussi eu une incidence sur des domaines variés tels que les mathématiques comme problèmes inversés, la théorie de la mesure géométrique, la géométrie différentielle et le règlement des singularités dans le cadre d'analyses complexes. Elle s'est penchée sur un nombre impressionnant de questions profondes et difficiles, de problèmes ouverts traditionnels et bien connus à la création de nouvelles voies dans des domaines émergents.

Son travail au début portait sur des problèmes traditionnels liés aux intégraux oscillatoires, aux opérateurs maximaux et de moyenne et

and combinatorial arguments. This territory has been explored extensively by many of the established leaders in the field, so that only the hardest problems remain. It is particularly remarkable that Pramanik, at this early stage of her career, managed to make significant contributions in this area. She then went on to launch several major projects in different directions. In a joint paper with Felea and Greenleaf, she applied powerful harmonic and microlocal analytic techniques to analyze a class of Fourier integral operators occurring naturally in inverse problems. Jointly with Collins and Greenleaf, she developed a constructive algorithm for the resolution of singularities, thus solving an important question in multivariate complex analysis. Yet another direction in her research involves function theory in several complex variables, where together with Nagel she was able to develop the (previously almost nonexistent) higher-dimensional theory and

Continued on page 86, please see Krieger-Nelson Prize

"While her work is deeply and solidly rooted in classical harmonic analysis, it has also made an impact in such diverse areas of mathematics as inverse problems, geometric measure theory, differential geometry and resolution of singularities in complex analysis."

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aux estimations d'équilibrage locales aux applications touchant les équations différentielles partielles dispersives. C'est un beau domaine des mathématiques qui conjugue l'analyse pure et des arguments géométriques et combinatoires ingénieux. Ce domaine a fait l'objet d'études approfondies par de nombreux chefs de file établis du domaine; par conséquent, seuls les problèmes les plus difficiles ne restent. Il est particulièrement remarquable que Mme Pramanik, à cette étape précoce de sa carrière, ait pu apporter de grandes contributions dans ce domaine. Elle a ensuite lancé plusieurs grands projets dans différentes directions. Dans un ouvrage rédigé conjointement avec Felea et Greenleaf, elle a appliqué de puissantes techniques d'analyse harmonique et d'analyse microlocale pour analyser une classe d'opérateurs intégraux de Fourier qui se surviennent naturellement dans des problèmes inversés. Conjointement avec Collins et Greenleaf, elle a créé un algorithme constructif pour régler les singularités et a résolu du coup une question importante de l'analyse complexe à variables multiples. Dans une autre orientation de sa recherche, elle s'intéresse à la théorie des fonctions dans plusieurs variables complexes, où ensemble avec Nagel, elle a pu formuler la théorie à dimension plus élevée (pratiquement non existante auparavant) et répondre à plusieurs questions naturelles. Récemment, dans des ouvrages rédigés conjointement avec Laba et Chan et Laba, elle a examiné la possibilité de transférer les résultats du domaine émergent de la combinatoire additive à la formulation continue de la théorie des mesures géométriques.

En particulier, leur travail a permis de trouver réponse à une question de vieille date d'Aversa et Preiss, dossier où peu de progrès avaient été réalisés. Ce travail fournit aussi des analogues analytiques naturels de résultats importants en combinatoire additive.

Suite à la page 176, veuillez consulter Prix Krieger-Nelson

Excellence in Teaching Award ,
continued from page 89

answer several natural questions. Recently, in joint papers with Laba, and Chan and Laba she examined the possibility of transferring the results from the emerging area of additive combinatorics to the continuous setting of geometric measure theory. In particular, their work resolves completely a long-standing question of Aversa and Preiss on which there had been very little progress previously, and provides natural analytic analogues of important results in additive combinatorics.

Pramanik was born in India, and obtained her bachelor's and master's degree in statistics from Indian Statistical Institute. She got her Ph.D. in mathematics from University of California at Berkeley in 2001 under the supervision of Michael Christ. Prior to joining the University of British Columbia in 2006, she held positions as a Van Vleck Visiting Assistant Professor at University of Wisconsin, Madison, and a Fairchild Senior Research Fellow at the California Institute of Technology, Pasadena. She received the US Junior Oberwolfach Fellowship in 2005, and was funded twice by the NSF before joining UBC. Pramanik is currently Associate Professor of Mathematics at UBC. She has held visiting positions at the University of Rochester, Indian Institute of Science, and Beijing Normal Unviersity, and was the winner of the 2015-2016 Ruth I. Michler Memorial Prize. Pramanik is an editor for the Transactions and Memoirs of the American Mathematical Society, and editor of the Proceedings of the Edinbugh Mathematical Society.

Prix d'excellence en enseignement
suite de la page page 89

Madame Pramanik est née en Inde et a obtenu son baccalauréat et sa maîtrise en statistiques de la Indian Statistical Institute. Elle a obtenu son doctorat en mathématiques de la University of California at Berkeley en 2001 sous la supervision de Michael Christ. Avant de se joindre à la University of British Columbia en 2006, elle a occupé des postes comme celui de chargée de cours invitée adjointe Van Vleck à la University of Wisconsin, Madison et celui de chercheuse principale Fairchild à la California Institute of Technology, à Pasadena. Elle a reçu la bourse US Junior Oberwolfach Fellowship en 2005 et a reçu du financement à deux reprises de la NSF avant de se joindre à la UBC. Madame Pramanik est actuellement professeure agrégée en mathématiques à la UBC. Elle a occupé des postes comme invitée à la University of Rochester, à la Indian Institute of Science et à la Beijing Normal University et elle a été lauréate du prix Ruth I. Michler Memorial Prize de 2015-2016. Madame Pramanik est éditrice pour Transactions and Memoirs de la American Mathematical Society et rédactrice des Proceedings de la Edinbugh.

« Même si son travail est profondément et solidement fondé sur l'analyse harmonique traditionnelle, il a aussi eu une incidence sur des domaines variés tels que les mathématiques comme problèmes inversés, la théorie de la mesure géométrique, la géométrie différentielle et le règlement des singularités dans le cadre d'analyses complexes. »

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Excellence in Teaching Award

Ian VanderBurgh

Prix d'excellence en enseignement

Ian VanderBurgh

Since joining the Faculty of Mathematics at the University of Waterloo in 2000, Ian VanderBurgh has made outstanding contributions to the development, delivery and teaching of mathematics. From elementary schools to graduate schools, Ian's work has reached countless students at Waterloo, across Canada, and, indeed, worldwide.

Ian's teaching has been addressed to diverse audiences, from struggling calculus students to Putnam students. His work with the Centre for Education in Mathematics and Computing and with the Master of Mathematics for Teachers program has had a significant influence on the community of students and teachers at large.

Within the Faculty of Mathematics Ian has earned enormous respect from faculty and students alike. His reputation and popularity are legendary and the influence he has had on students and teachers will propagate for years to come. He understands students' needs and knows where and when they

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Depuis qu'il s'est joint à la Faculté des mathématiques à la University of Waterloo en 2000, Ian VanderBurgh a apporté une contribution exceptionnelle au développement, à la prestation et à l'enseignement des mathématiques. Du primaire aux études supérieures, Ian a réussi à capter l'imagination de nombreux étudiants à Waterloo, dans tout le Canada et aussi dans le monde entier.

Ian a enseigné à divers étudiants, notamment à des étudiants en calcul éprouvant des difficultés et à des étudiants Putnam. Son travail auprès du Centre for Education in Mathematics and Computing et du programme de maîtrise en mathématiques à l'intention des enseignants a eu une influence marquée sur les étudiants et les enseignants en général.

Au sein de la Faculté des mathématiques, Ian est très respecté des membres enseignants et des étudiants. Sa réputation et sa popularité font

"His reputation and popularity are legendary and the influence he has had on students and teachers will propagate for years to come. He understands students' needs and knows where and when they will have difficulties with the material."

will have difficulties with the material. He carefully prepares and presents material in a way that is easy to understand, with motivating examples and insightful observations. He explains difficult concepts with great patience, kindness and humour. At the same time, he is able to challenge even the best students in class.

Ian's deep commitment and dedication to teaching and to students extends well beyond the classroom. He has assisted with the coaching of the Waterloo Putnam team and participated in developing and administering three University of Waterloo undergraduate math contests. In addition, as the Director of the Centre for Education in Mathematics and Computing (CEMC), a position which he has held since 2005, he has led numerous initiatives to promote mathematics which include contests, high school visits, student and teacher workshops, and online resources. Under his leadership the CEMC received the 2014 NSERC Award for Science Promotion. He has visited countless elementary and high schools across Canada and abroad to conduct problem-solving workshops. He also has made regular contributions to the Crux journal.

Continued on page 89, please see Excellence in Teaching Award

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figure de légende et son influence sur les étudiants et les enseignants se poursuivra pendant des années encore. Il comprend les besoins des étudiants et sait où et à quel moment ils auront de la difficulté à comprendre ce qu'il enseigne. Il prépare et présente judicieusement le matériel de cours de manière à ce qu'il soit facile à comprendre et offre des exemples motivants et de bonnes observations. Il explique des notions difficiles avec grande patience, amabilité et humour. Il est toutefois capable de mettre au défi même les plus brillants étudiants de la classe.

Son engagement profond et son dévouement à l'enseignement et aux étudiants vont bien au-delà de la salle de classe. Il a aidé à entraîner l'équipe Putnam de Waterloo et a participé à la création de trois concours de mathématiques pour étudiants de premier cycle à la University of Waterloo. De plus, en sa qualité de directeur du Centre for Education in Mathematics and Computing (CEMC), poste qu'il occupe depuis 2005, Ian a été responsable de nombreuses initiatives visant à promouvoir les mathématiques, notamment des concours, des visites d'étudiants du secondaire, des ateliers à l'intention d'étudiants et d'enseignants et des ressources en ligne. Sous son leadership, le CEMC s'est vu décerner le Prix du CRSNG de 2014 pour la promotion des sciences. Il a visité d'innombrables écoles primaires et secondaires au Canada et à l'étranger afin d'animer des ateliers sur la résolution de problèmes. Il contribue aussi régulièrement à la revue spécialisée Crux.

Un des membres du Comité de sélection des prix à l'enseignement de la SMC a écrit ce qui suit à propos d'Ian :

« Selon moi, ce qui m'a impressionné le plus au sujet de la candidature d'Ian est le large éventail de ses contributions à l'enseignement

Suite à la page 89, veuillez consulter Prix d'excellence en enseignement

Excellence in Teaching Award ,
continued from page 89

One of the members of the CMS Teaching Award Selection Committee wrote about Ian:

"For me, the most impressive part of Ian's nomination was the wide range of his contributions to the mathematical education at the University of Waterloo, but also nationally and internationally. It seems to me that with math contests, articles in Crux, and his involvement in the master's program for teachers, Ian has reached out to learners in all corners of Canada and the world."

Ian's innovative techniques, energy and dedication have earned him a great deal of admiration and the respect of his students, as reflected in their comments about him:

"… I struggled through my first year of university, and by the time I found myself in Mr. VanderBurgh's course, I had accepted that university mathematics was going to be difficult for me, and I had lowered expectations of myself accordingly. All of that changed in Mr. VanderBurgh's lecture hall. His enthusiasm for the subject matter was contagious and he was always able to explain a concept in another way if I was having difficulty. He also had a great sense of humour and made an effort to get to know each and every student. He never forgets a name! … I finished his course with a confidence I hadn't yet felt in university, and I was enjoying the mathematics again!"

"… His passion for the abstract beauty of mathematics made me fall in love with it too, and his clarity and intuition for the subject made me see past the formulas and notation to the real core of the subject. …"

"… One of things that strikes me as so exemplary is how well he gets to know his students. In the elementary number theory course I took, our first assignment was simply to come by his office and introduce ourselves and why we were taking the course. This was a class of over one hundred students and he took the time to meet with them in a one on one fashion to get to know them and to get them over the intimidating hurdle of meeting the professor in his office …"

"… Ian has a fantastic feel for the material and his students. He knows when to slow down and review a concept to let the students catch up, but also knows when to stop holding hands and allow the class to read and understand the material on their own time. So many professors I have encountered will either solve the problems for you with no regard for your learning or understanding, or treat you with disdain for not having the same grasp of the material that they do. But not Ian. He is always able to talk to you as a colleague and give you explanations and hints that spur on your learning …"

Ian earned his B Math at the University of Waterloo in 1999 and his MSc at the University of Toronto in 2000. He joined the Faculty of Mathematics at the University of Waterloo as a lecturer in 2000. In 2005, he became the Director of the Centre for Education in Mathematics and Computing, Faculty of Mathematics, University of Waterloo. During his tenure there, he won several teaching awards, including Faculty of Mathematics Award for Distinction in Teaching (2007), and University of Waterloo Distinguished Teacher Award (2008).

des mathématiques à la University of Waterloo, mais aussi dans tout le pays et à l'échelle internationale. Il me semble qu'avec les concours de mathématiques, les articles dans Crux et sa participation au programme de maîtrise pour les enseignants, Ian s'est adressé aux apprenants de tous les coins du Canada et du monde entier ».

Ses techniques novatrices, son énergie et son dévouement lui ont valu l'admiration et le respect de ses étudiants, comme on peut le constater dans leurs commentaires à son sujet :

« … J'ai eu de la difficulté pendant toute ma première année d'université et avant de me retrouver inscrit au cours que donnait M. VanderBurgh, j'avais accepté que les mathématiques à l'université seraient laborieuses pour moi. J'avais donc de moindres attentes personnelles. Tout a changé dans la salle de cours où M. VanderBurgh donnait son cours. Son enthousiasme pour le sujet d'enseignement était contagieux et il savait comment expliquer une notion d'une autre façon si j'avais de la difficulté à comprendre. Il a aussi un grand sens de l'humour et a fait un effort pour apprendre à connaître chacun des étudiants. Il n'oublie jamais un nom! … j'ai terminé le cours rempli d'une confiance que je n'avais jamais ressentie depuis mon arrivée à l'université et j'ai repris plaisir à étudier les mathématiques! »

« … sa passion pour la beauté abstraite des mathématiques m'a fait tomber amoureux du sujet aussi, et sa clarté et son intuition pour le sujet m'ont fait aller au-delà des formules et des notations et voir le cœur véritable du sujet. …"

« … une des choses qui me paraissent extrêmement exemplaires est à quel point il connaît bien ses étudiants. Dans le cours de théorie des nombres de base que j'ai suivi, notre premier travail pratique consistait tout simplement à passer à son bureau et à se présenter et à expliquer nos motifs pour avoir pris le cours. C'était un cours comptant plus de cent étudiants, et il a pris le temps de rencontrer

« Sa réputation et sa popularité font figure de légende et son influence sur les étudiants et les enseignants se poursuivra pendant des années encore. Il comprend les besoins des étudiants et sait où et à quel moment ils auront de la difficulté à comprendre ce qu'il enseigne. »

chacun d'eux, une personne à la fois. C'était aussi sa façon de leur faire passer l'étape intimidante d'aller rencontrer un professeur dans son bureau… »

« … Ian a un sens inné de la matière qu'il enseigne et pour ses étudiants. Il sait quand ralentir la cadence et revoir une notion pour permettre aux étudiants de se rattraper, mais il sait aussi quand lâcher prise et permettre à la classe de lire et de comprendre le matériel à son propre rythme. Nombre de professeurs que j'ai rencontrés vont solutionner les problèmes pour vous sans se soucier de votre apprentissage ou du fait que vous ayez compris ou non ou vous traitent avec dédain pour ne pas avoir la même maîtrise du matériel qu'eux. Mais ce n'est pas le cas d'Ian. Il est toujours capable de vous parler comme un collègue et de vous donner des explications et des astuces qui favorisent votre apprentissage… »

Ian a obtenu son baccalauréat en mathématiques de la University of Waterloo en 1999 et sa maîtrise en sciences à la University of Toronto en 2000. Il s'est joint à la Faculté des mathématiques à la University of Waterloo comme chargé de cours en 2000. En 2005, il est devenu directeur du Centre for Education in Mathematics and Computing, de la Faculté des mathématiques à la University of Waterloo. Pendant son mandat à titre de directeur, il a remporté plusieurs prix d'enseignement, y compris le prix de la Faculté des mathématiques pour distinction en enseignement (2007) et le prix de l'enseignant distingué de la University of Waterloo (2008).

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FRIDAY 3:30-6:30PM

Chateau Lacombe	Education	Lister Centre
3:30 PM		**3:45 PM**
4:00 PM		**4:15 PM**
4:30 PM	4:40 PM	**4:45 PM**
5:00 PM	5:10 PM	**5:15 PM**
5:30 PM	5:40 PM	**5:45 PM**
	5:50 PM	**5:55 PM**
	6:00 PM	**6:05 PM**
	6:10 PM	**6:15 PM**
	6:20 PM	**6:25 PM**
	6:30 PM	

FRIDAY 7:00PM-8:30PM

Lister Centre	Chateau LaCombe
7:00PM	7:15PM
7:30PM	7:45PM
8:00PM	8:15PM
8:30PM	

SATURDAY 7:30AM-10:40AM

Chateau Lacombe	Education Building	Lister Centre
7:30AM	7:40AM	**7:45AM**
8:00AM	8:10AM	**8:15AM**
8:30AM	8:40AM	**8:45AM**
9:00AM	9:10AM	**9:15AM**
9:30AM	9:40AM	**9:45AM**
	9:50 AM	**9:55 AM**
	10:00 AM	**10:05 AM**
	10:10 AM	**10:15 AM**
	10:20 AM	**10:25 AM**
	10:30 AM	**10:35 AM**
	10:40 AM	

SATURDAY 2:45PM-7:05PM

Lister Centre	Education	Chateau Lacombe
2:45 PM	2:50 PM	
2:55 PM	3:00 PM	
3:05 PM	3:10 PM	
3:15 PM	3:20 PM	
3:25 PM	3:30 PM	
3:35 PM	3:40 PM	
3:45 PM	3:50 PM	
4:00PM	4:05PM	**4:20PM**
4:35PM	4:40PM	**4:50PM**
5:05PM	5:10PM	**5:20PM**
5:35PM	5:40PM	**5:50PM**
6:05PM	6:10PM	**6:20PM**
6:35PM		**6:50PM**
7:05PM		

SATURDAY 9:30PM-11:00PM

Lister Centre	Chateau Lacombe
9:30PM	9:45PM
10:00PM	10:15PM
10:30PM	10:45PM
11:00PM	

SUNDAY 7:30AM-10:40AM

Chateau Lacombe	Education	Lister Centre
7:30 AM	7:40 AM	**7:45 AM**
8:00 AM	8:10 AM	**8:15 AM**
8:30 AM	8:45 AM	**8:50 AM**
9:05 AM	9:20 AM	**9:25 AM**
	9:30 AM	**9:35 AM**
	9:40 AM	**9:45 AM**
	9:50 AM	**9:55 AM**
	10:00 AM	**10:05 AM**
	10:10 AM	**10:15 AM**
	10:20 AM	**10:25 AM**
	10:30 AM	**10:35 AM**
	10:40 AM	

SUNDAY 2:45PM-9:00PM

Lister Centre	Education	Chateau Lacombe
2:45 PM	2:50 PM	
2:55 PM	3:00 PM	
3:05 PM	3:10 PM	
3:15 PM	3:20 PM	
3:25 PM	3:30 PM	
3:35 PM	3:40 PM	
3:45 PM	3:50 PM	
4:00PM	4:05 PM	**4:15 PM**
4:30 PM	4:35 PM	**4:45 PM**
5:00 PM	5:05 PM	**5:15 PM**
5:30 PM	5:35 PM	**5:45 PM**
6:00 PM		**6:15 PM**
6:30PM		**6:45 PM**
7:00 PM		**7:15 PM**
7:30 PM		**7:45 PM**
8:00 PM		**8:15 PM**
8:30 PM		**8:45 PM**

MONDAY 7:30AM-10:40AM

Chateau Lacombe	Education Building	Lister Centre
7:30 AM	7:40 AM	**7:45 AM**
8:00 AM	8:10 AM	**8:15 AM**
8:30 AM	8:40 AM	**8:45 AM**
9:00 AM	9:10 AM	**9:15 AM**
9:30 AM	9:40 AM	**9:45 AM**
	9:50 AM	**9:55 AM**
	10:00 AM	**10:05 AM**
	10:10 AM	**10:15 AM**
	10:20 AM	**10:25 AM**
	10:30 AM	**10:35 AM**
	10:40 AM	

MONDAY 1:00-5:00PM

Lister Centre	Education Building	Chateau Lacombe
1:00 PM	1:05 PM	**1:15 PM**
1:30 PM	1:35 PM	**1:45 PM**
2:00 PM	2:05 PM	**2:15 PM**
2:30 PM	2:35 PM	**2:45 PM**
3:00PM	3:05PM	**3:15PM**
3:25PM	3:30PM	**3:40PM**
3:50PM	3:55PM	**4:05PM**
4:15PM	4:20PM	**4:30PM**
4:40PM	4:45PM	

Call for Nominations
CJM/CMB Associate Editors

The Publications Committee of the CMS solicits nominations for Associate Editors for the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB). The appointment will be for five years beginning January 1, 2017. The current members (with their end of term) are below.

For over fifty years, the **Canadian Journal of Mathematics** (CJM) and the **Canadian Mathematical Bulletin** (CMB) have been the flagship research journals of the Society, devoted to publishing original research works of high standard. The CJM publishes longer papers with six issues per year and the CMB publishes shorter papers with four issues per year. CJM and CMB are supported by respective Editors-in-Chief and share a common Editorial Board.

Expressions of interest should include your curriculum vitae, your cover letter and sent electronically to: **cjmcmb-ednom-2016@cms.math.ca** **before September 15th 2016.**

Current members of CJM/CMB editorial board:

Henry Kim (Toronto)	12/2016	Editor-in-Chief CJM
Robert McCann (Toronto)	12/2016	Editor-in-Chief CJM
Jie Xiao (Memorial)	12/2019	Editor-in-Chief CMB
Xiaoqiang Zhao (Memorial)	12/2019	Editor-in-Chief CMB
Louigi Addario-Berry (McGill)	12/2018	Associate Editor
Jason Bell (Waterloo)	12/2020	Associate Editor
Hans Boden (McMaster)	12/2020	Associate Editor
Alexander Brudnyi (Calgary)	12/2020	Associate Editor
Florin Diacu (Victoria)	12/2016	Associate Editor
Ilijas Farah (York)	12/2020	Associate Editor
Ailana Fraser (UBC Vancouver)	12/2020	Associate Editor
Skip Garibaldi (UCLA)	12/2016	Associate Editor
Dragos Ghioca (UBC Vancouver)	12/2018	Associate Editor
Eyal Goren (McGill)	12/2018	Associate Editor
Robert Leon Jerrard (Toronto)	12/2016	Associate Editor
Anthony To-Ming Lau (Alberta)	12/2016	Associate Editor
Alexander Litvak (Alberta)	12/2016	Associate Editor
Javad Mashreghi (Laval)	12/2020	Associate Editor
Marco Merkli (Memorial)	12/2020	Associate Editor
Assaf Naor (Princeton)	12/2018	Associate Editor
Erhard Neher (Ottawa)	12/2016	Associate Editor
Nilima Nigam (Simon Fraser)	12/2020	Associate Editor
McKenzie Wang (McMaster)	12/2016	Associate Editor
Juncheng Wei (UBC Vancouver)	12/2018	Associate Editor
Daniel Wise (McGill)	12/2018	Associate Editor
Efim Zelmanov (UCSD)	12/2016	Associate Editor

Appel à candidatures
Rédacteur(trice) associé(e) pour le JCM et le BCM

Le Comité des publications de la SMC sollicite des mises en candidatures pour des rédacteurs associés pour le Journal canadien de mathématiques (JCM) et pour le Bulletin Canadien de mathématiques (BCM). Le mandat sera de cinq ans qui commencera le 1er janvier 2017. Les membres actuels (avec la fin de leur terme) sont ci-dessous.

Revues phares de la Société depuis plus de 50 ans, le **Journal canadien de mathématiques** (JCM) et le **Bulletin canadien de mathématiques** (BCM) présentent des travaux de recherche originaux de haute qualité. Le JCM publie des articles longs dans ses six numéros annuels, et le BCM publie des articles plus courts quatre fois l'an. Le JCM et le BCM ont chacun leur rédacteur en chef et partagent un même conseil de rédaction.

Les propositions de candidature doivent inclure votre curriculum vitae, votre lettre de présentation et doivent être envoyé par courriel électronique à : **jcmbcm-rednom-2016@smc.math.ca** **au plus tard le 15 septembre 2016.**

Membres Actuels du Conseil de rédaction scientifique pour le JCM et le BCM:

Henry Kim (Toronto)	12/2016	Rédacteur en chef JCM
Robert McCann (Toronto)	12/2016	Rédacteur en chef JCM
Jie Xiao (Memorial)	12/2019	Rédacteur en chef BCM
Xiaoqiang Zhao (Memorial)	12/2019	Rédacteur en chef BCM
Louigi Addario-Berry (McGill)	12/2018	Rédacteur associé
Jason Bell (Waterloo)	12/2020	Rédacteur associé
Hans Boden (McMaster)	12/2020	Rédacteur associé
Alexander Brudnyi (Calgary)	12/2020	Rédacteur associé
Florin Diacu (Victoria)	12/2016	Rédacteur associé
Ilijas Farah (York)	12/2020	Rédacteur associé
Ailana Fraser (UBC Vancouver)	12/2020	Rédactrice associée
Skip Garibaldi (UCLA)	12/2016	Rédacteur associé
Dragos Ghioca (UBC Vancouver)	12/2018	Rédacteur associé
Eyal Goren (McGill)	12/2018	Rédacteur associé
Robert Leon Jerrard (Toronto)	12/2016	Rédacteur associé
Anthony To-Ming Lau (Alberta)	12/2016	Rédacteur associé
Alexander Litvak (Alberta)	12/2016	Rédacteur associé
Javad Mashreghi (Laval)	12/2020	Rédacteur associé
Marco Merkli (Memorial)	12/2020	Rédacteur associé
Assaf Naor (Princeton)	12/2018	Rédacteur associé
Erhard Neher (Ottawa)	12/2016	Rédacteur associé
Nilima Nigam (Simon Fraser)	12/2020	Rédactrice associée
McKenzie Wang (McMaster)	12/2016	Rédacteur associé
Juncheng Wei (UBC Vancouver)	12/2018	Rédacteur associé
Daniel Wise (McGill)	12/2018	Rédacteur associé
Efim Zelmanov (UCSD)	12/2016	Rédacteur associé

Call for Nominations – *CMS Research Prizes*

The CMS Research Committee is inviting nominations for three prize lectureships. These prize lectureships are intended to recognize members of the Canadian mathematical community.

The ***Coxeter-James Prize*** Lectureship recognizes young mathematicians who have made outstanding contributions to mathematical research. The recipient shall be a member of the Canadian mathematical community. Nominations may be made up to ten years from the candidate's Ph.D. A nomination can be updated and will remain active for a second year unless the original nomination is made in the tenth year from the candidate's Ph.D. For more information, visit: **https://cms.math.ca/Prizes/cj-nom**

The ***Jeffery-Williams Prize*** Lectureship recognizes mathematicians who have made outstanding contributions to mathematical research. The recipient shall be a member of the Canadian mathematical community. A nomination can be updated and will remain active for three years. For more information: **https://cms.math.ca/Prizes/jw-nom**

The ***Krieger-Nelson Prize*** Lectureship recognizes outstanding research by a female mathematician. The recipient shall be a member of the Canadian mathematical community. A nomination can be updated and will remain active for two years. For more information: **https://cms.math.ca/Prizes/kn-nom**

The deadline for nominations, including at least three letters of reference, is **September 30, 2016**. Nomination letters should list the chosen referees and include a recent curriculum vitae for the nominee. Some arms-length referees are strongly encouraged. Nominations and the reference letters from the chosen referees should be submitted electronically, preferably in PDF format, to the corresponding email address and **no later than September 30, 2016 :**

Coxeter-James: **cjprize@cms.math.ca**
Jeffery-Williams: **jwprize@cms.math.ca**
Krieger-Nelson: **knprize@cms.math.ca**

Appel à candidatures *Prix de recherche de la SMC*

Le Comité de recherche de la SMC lance un appel de mises en candidatures pour trois de ses prix de conférence. Ces prix ont tous pour objectif de souligner l'excellence de membres de la communauté mathématique canadienne.

Le ***Prix Coxeter-James*** rend hommage aux jeunes mathématiciens qui se sont distingués par l'excellence de leur contribution à la recherche mathématique. Cette personne doit être membre de la communauté mathématique canadienne. Les candidats sont admissibles jusqu'à dix ans après l'obtention de leur doctorat. Toute mise en candidature est modifiable et demeurera active l'année suivante, à moins que la mise en candidature originale ait été faite la 10e année suivant l'obtention du doctorat. Pour les renseignements, voir : **https://cms.math.ca/Prix/cj-nom**

Le ***Prix Jeffery-Williams*** rend hommage aux mathématiciens ayant fait une contribution exceptionnelle à la recherche mathématique. Cette personne doit être membre de la communauté mathématique canadienne. Toute mise en candidature est modifiable et demeurera active pendant trois ans. Pour les renseignements, voir : **https://cms.math.ca/Prix/jw-nom**

Le ***Prix Krieger-Nelson*** rend hommage aux mathématiciennes qui se sont distinguées par l'excellence de leur contribution à la recherche mathématique. La lauréate doit être membre de la communauté mathématique canadienne. Toute mise en candidature est modifiable et demeurera active pendant deux ans. Pour les renseignements, voir : **https://cms.math.ca/Prix/info/kn**

La date limite pour déposer une candidature, qui comprendra au moins trois lettres de référence, est le **30 septembre 2016**. Le dossier de candidature doit comprendre le nom des personnes données à titre de référence ainsi qu'un curriculum vitae récent du candidat ou de la candidate. Nous vous incitons fortement à fournir des références indépendantes. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, à l'adresse électronique correspondante et **au plus tard le 30 septembre 2016** :

Coxeter-James : **prixcj@smc.math.ca**
Jeffery-Williams : **prixjw@smc.math.ca**
Krieger-Nelson : **prixkn@smc.math.ca**

2017 CMS WINTER MEETING
DECEMBER 8-11
RÉUNION D'HIVER DE LA SMC 2017
8-11 DECEMBRE

Call for Sessions
Nous vous invitons

The Canadian Mathematical Society (CMS) welcomes and invites proposals for sessions for the 2017 CMS Winter Meeting in Waterloo. Proposals should include a brief description of the focus and purpose of the session, the expected number of speakers, as well as the organizer's name, complete address, telephone number, e-mail address, etc. All sessions will be advertised in the CMS Notes, on the CMS web site and in the AMS Notices. Speakers will be requested to submit abstracts, which will be published on the web site and in the meeting program. Those wishing to organize a session should send a proposal to the scientific directors.

La Société mathématique du Canada (SMC) vous invitent à proposer des séances pour la Réunion d'hiver de la SMC 2017 qui se tiendra Waterloo. Ces propositions de séances doivent presenter une brève description de l'orientation et les objectifs de la séance, le nombre de conférenciers prévu, de même que le nom, l'adresse complète, le numéro de téléphone et l'adresse électronique de l'organisateur. Toutes les séances seront annoncées dans les Notes de la SMC, sur le site Web et dans les AMS Notices. Les conférenciers devront présenter un résumé, qui sera publié sur le site Web SMC et dans le programme de la réunion. Toute personne qui souhaiterait organiser une séance est priée de faire parvenir une proposition aux directeurs scientifiques.

@CMSwinter
@hiverSMC

Contact us | Contactez nous :

Ken Davidson, University of Waterloo, krdavids@uwaterloo.ca
Cam Stewart, University of Waterloo, cstewart@uwaterloo.ca

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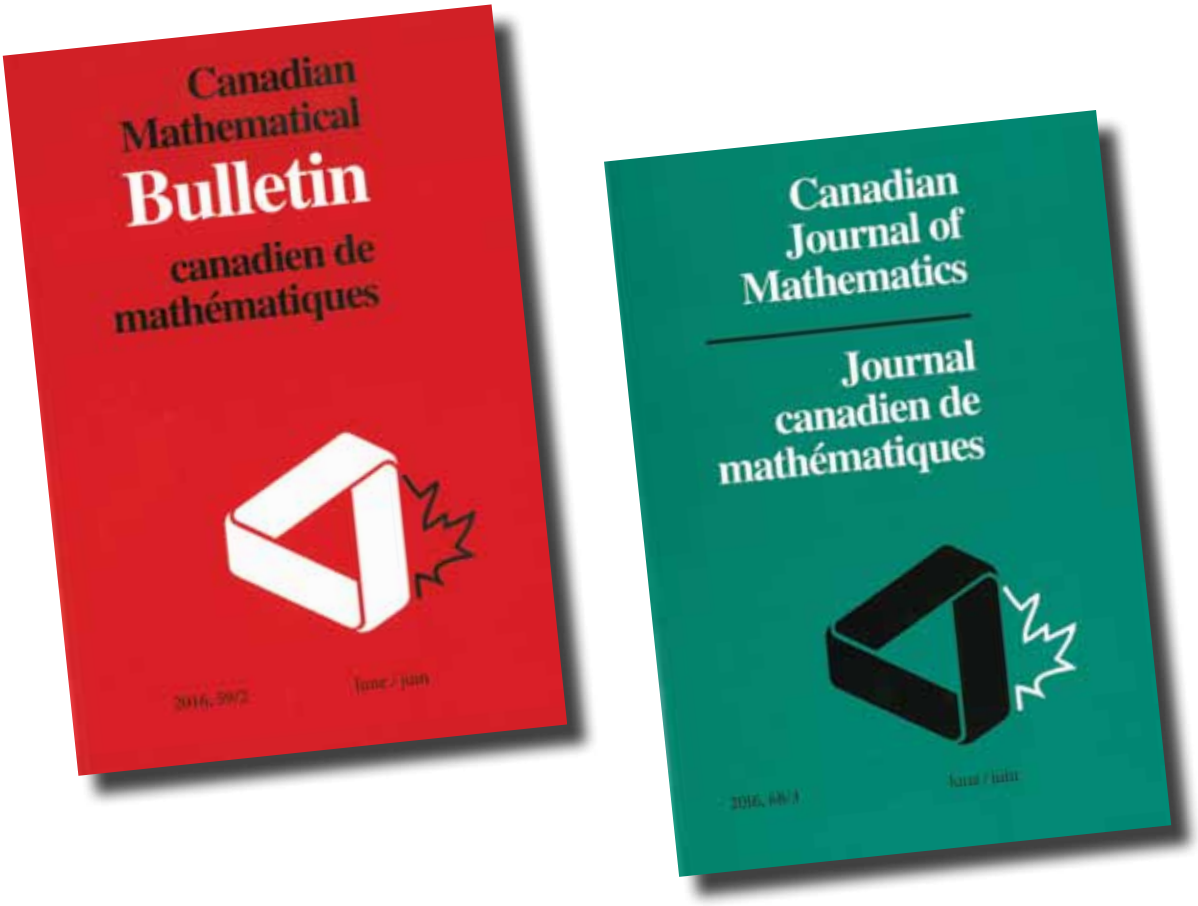

CJM and CMB Bring Together Open Access and Traditional Publishing

For many decades, the Society's flagship research journals, the **Canadian Journal of Mathematics (CJM)** and the **Canadian Mathematical Bulletin (CMB)**, have brought original peer-reviewed research of high standard to our subscribers. When the web became available, we quickly moved to online access for our subscribers, but also made all our older issues (anything more than five years old) available without subscription to the wider research community. This spring, the CMS has begun allowing designated papers to be publicly accessible without a subscription.

Both journals now permit authors to pay a one-time fee so their papers are immediately and permanently free to the public. We offer this **Gold Open Access** option to authors only after peer review and paper acceptance is complete, ensuring that the quality standards of our editorial process are entirely unbiased.

Additionally, the Society provides for **Green Open Access** self-archiving by authorizing all authors to post the peer-reviewed pre-publication version of accepted papers (but not the final published version) to their own academic websites and similar non-commercial repositories such as arXiv.org, to increase the reach of their research. The final published version of a paper remains exclusive to our own online site and our print subscribers.

For more information on the details and background of our hybrid Traditional/Open Access model, please visit https://cms.math.ca/cjm/openaccess for CJM and https://cms.math.ca/cmb/openaccess for CMB.

CMS
SMC

NIAGARA FALLS 2016

WILL YOU BE THERE? · SEREZ-VOUS PRÉSENTS ?

2016 WINTER MEETING · RÉUNION D'HIVER DE LA SMC 2016

DECEMBER 2-5 · 2-5 DÉCEMBRE

CMS.MATH.CA/EVENTS/WINTER16
SMC.MATH.CA/REUNIONS/HIVER16

2016 CMS WINTER MEETING
DECEMBER 2-5

RÉUNION D'HIVER DE LA SMC 2016
2-5 DECEMBRE

Call for Sessions
Nous vous invitons

The Canadian Mathematical Society (CMS) welcomes and invites proposals for sessions for the 2016 CMS Winter Meeting in Niagara Falls. Proposals should include a brief description of the focus and purpose of the session, the expected number of speakers, as well as the organizer's name, complete address, telephone number, e-mail address, etc. All sessions will be advertised in the CMS Notes, on the CMS web site and in the AMS Notices. Speakers will be requested to submit abstracts, which will be published on the web site and in the meeting program. Those wishing to organize a session should send a proposal to the scientific directors.

La Société mathématique du Canada (SMC) vous invitent à proposer des séances pour la Réunion d'hiver de la SMC 2016 qui se tiendra Niagara Falls. Ces propositions de séances doivent presenter une brève description de l'orientation et les objectifs de la séance, le nombre de conférenciers prévu, de même que le nom, l'adresse complète, le numéro de téléphone et l'adresse électronique de l'organisateur. Toutes les séances seront annoncées dans les Notes de la SMC, sur le site Web et dans les AMS Notices. Les conférenciers devront présenter un résumé, qui sera publié sur le site Web SMC et dans le programme de la réunion. Toute personne qui souhaiterait organiser une séance est priée de faire parvenir une proposition aux directeurs scientifiques.

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Contact us | Contactez nous :

Hans Boden, McMaster University, boden@mcmaster.ca
Bartosz Protas, McMaster University, bprotas@mcmaster.ca

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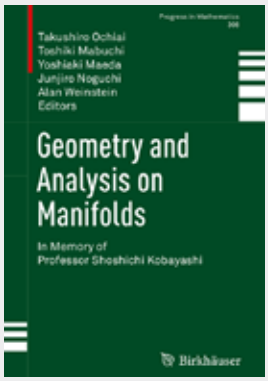
Research in Number Theory
Editor-in-Chief: Ken Ono

This is an international, peer-reviewed Open Access Journal covering the scope of the mathematical disciplines of Number Theory and Arithmetic Geometry

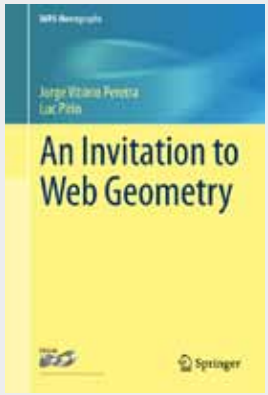
Geometry and Analysis on Manifolds
Editors: T. Ochiai, T. Mabuchi, Y. Maeda, J. Noguchi, A. Weinstein

Presents lectures on recent topics in complex geometry and complex analysis for young researchers



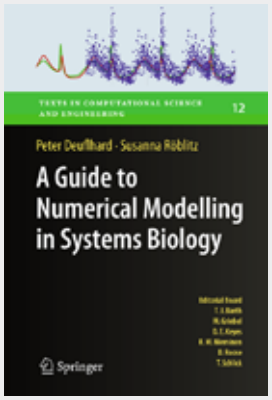
An Invitation to Web Geometry
By Jorge Vitorio Pereira, Luc Pirio

This book takes an in-depth look at abelian relations of codimension one webs in the complex analytic setting



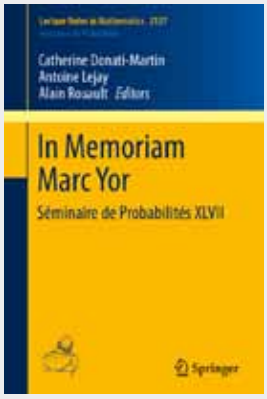
A Guide to Numerical Modelling in Systems Biology
By Peter Deuflhard, Susanna Röblitz

This book is intended for students of computational systems biology with only a limited background in mathematics



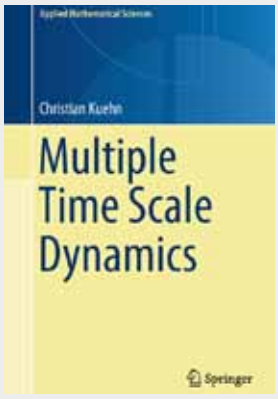
In Memoriam Marc Yor – Séminaire de Probabilités XLVII
Editors: Catherine Donati-Martin, Antoine Lejay, Alain Rouault

This volume is dedicated to the memory of Marc Yor and his research which covered broad areas of probability theory



Multiple Time Scale Dynamics
By Christian Kuehn

This book provides an introduction to dynamical systems with multiple time scales



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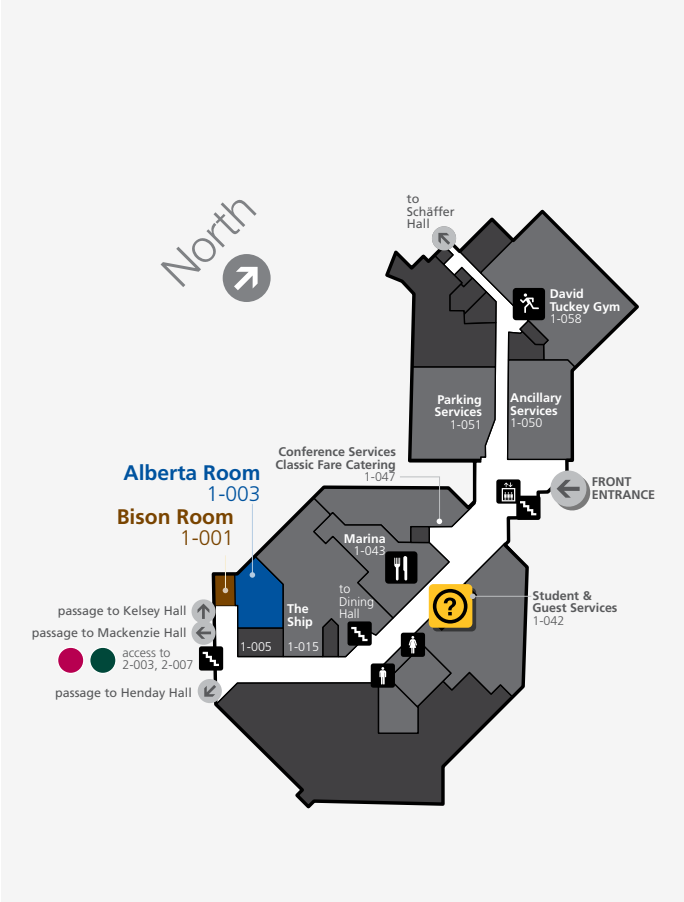
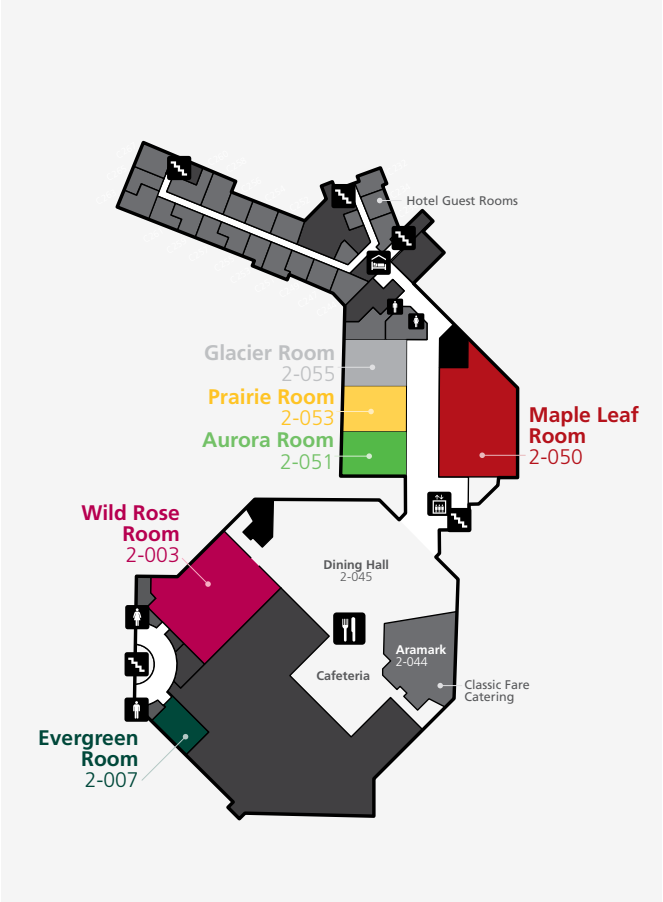
A20236

University of Alberta - Lister Centre Map / l`Université de l'Alberta Centre Lister

1st floor / premier étage



2nd floor / 2e étage



3rd floor - 3e étage

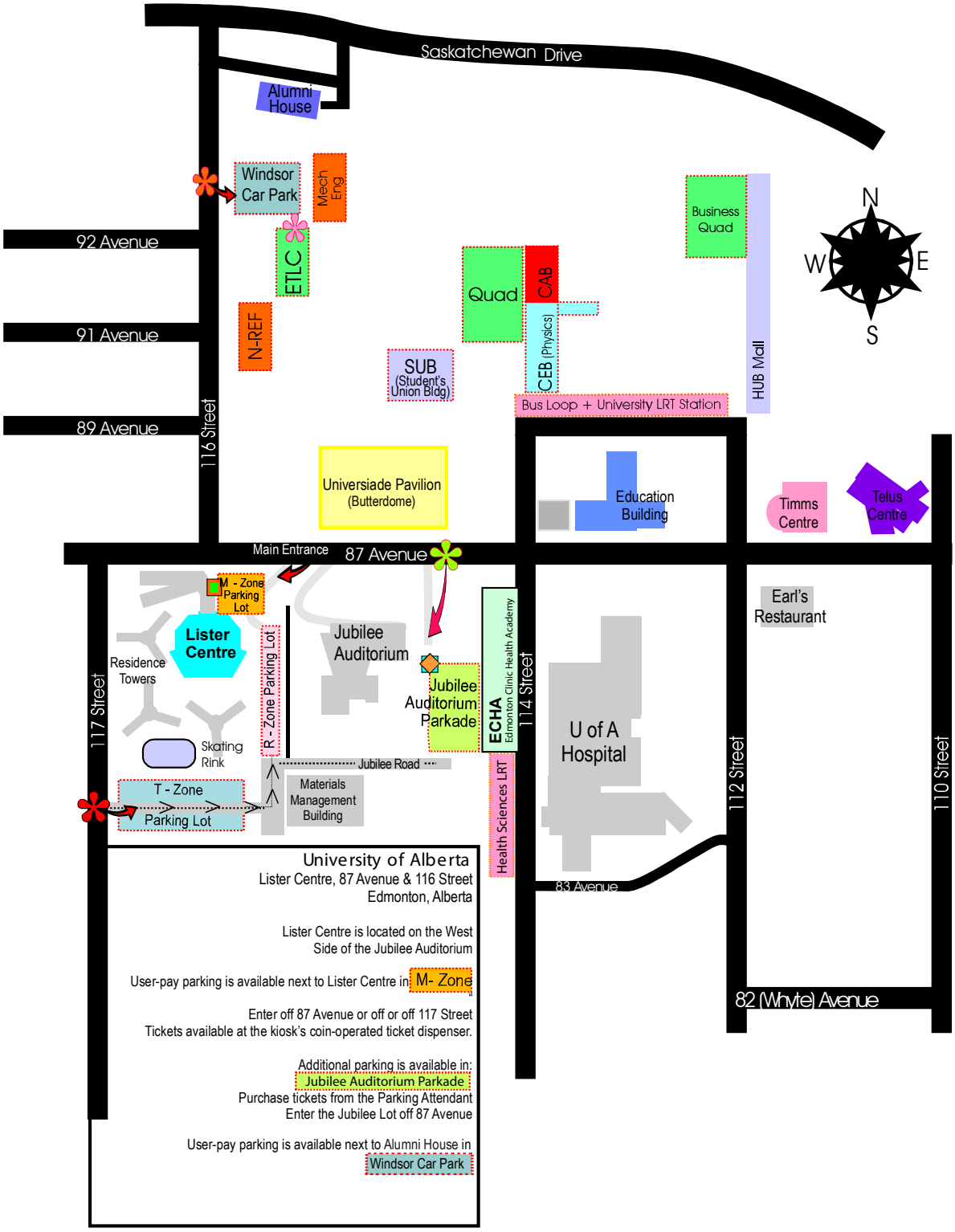
Floor Plan / Plan d’étage

1st floor / premier étage

2nd floor / 2e étage

3rd floor - 3e étage

Campus Map / Carte de campus



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