



2014 CMS Winter Meeting Notes **14**

CMS NOTES

September/ septembre 2014

de la SMC

IN THIS ISSUE DANS CE NUMÉRO

Vice-President's Notes	1
Notes du vice-président	3
Editorial Notes	
Helpful history of ideas / Histoire utile d'idées	2
Calendar of Events Notes	5
Book Review Notes	7
Turbulent Times in Mathematics: The Life of J.C. Fields and the History of the Fields Medal	7
Education Notes	8
About Your Use of Computer Algebra Systems (CAS) in University Teaching: A Canadian Survey	8
Mathematics and Outreach: Some Notes from British Columbia	8
Research Notes	10
Combinatorial Hopf Algebra and Positivity ...	10
Applications of Harmonic Analysis to the Theory of Cardinal Invariants	12
Dr. Garth H. M. Thomas (1926 -2014)	11
CMS Member Profile	13
2014 CMS Winter Meeting Notes / Réunion d'hiver 2014 de la SMC	14
Notes from the CSHPM	16
Call for Nominations Notes	18
CUMC 2014 Notes	19
IMO Report Notes	20



Notes du vice-président

Louigi Addario-Berry, Vice-Président, Québec



In June, 1945, the first Canadian Mathematical Congress was held in Montreal; here begins the history of the Canadian Mathematical Society. This summer therefore marked the beginning of our 70th year as the representative body for mathematics in Canada.

This summer marks two other milestones. First for the CMS: for the third time since 1945, the CMS president is a woman: Professor Lia Bronsard, of McMaster University, who is the thirty-third CMS/ Canadian Mathematical Congress president. Second, for mathematics as a whole: Maryam Mirzakhani has been awarded a Fields medal. Of the fifty-six Fields Laureats, dating back to 1936, she is the first woman. I want to use this as an opportunity to discuss gender imbalance and structural inequality in mathematics, with a focus on what men can do to help address these. (I will not spend time making the case that inequality exists, or that this inequality is unjust rather than, say, based on innate differences in ability. Those of you who wish to delve into the evidence can find one avenue by which to do so at www.nature.com/women.)

It is, of course, good for the advancement of women in mathematics to have women in leadership and mentorship roles. However, we should be aware that we may expect women to wear more hats than we would require from a man in the same position. If there is an assumption that as a Fields medalist, Mirzakhani is a *de facto* spokesperson for women in mathematics or that, in addition to the regular CMS presidential duties, Bronsard should automatically be involved in CMS initiatives addressed toward women, then we are placing additional obligations, perhaps easily overlooked, on their shoulders. At the risk of belabouring the point, let me emphasize that we would be unlikely to view a man in the same position as having these responsibilities.

This is an issue I believe we should all pay attention to more generally. Here is another example. In March 2012, France's Assemblée nationale passed a law designed to promote professional parity between men and women and to combat discrimination. Among the provisions of the law is a requirement that for any public body, at least 40% of the members of boards of directors



Figure 1 The conference photo from the 1945 Canadian Mathematical Congress (available online at <http://cms.math.ca/Historical/1945/>). Though we have the registration list, most of those in the photo have not been identified. Von Neumann has been found (bottom row, second from right), but Birkhoff, who also attended, has not.

Srinivasa Swaminathan,
Dalhousie University, Halifax, NS



Helpful history of ideas

It is interesting and instructive to study the origin and development of mathematical concepts and their names. It is part of the study of the history of mathematics in general. Without going deep into the history, some knowledge of how

certain ideas developed will help towards a good grasp of topics, theorems and their proofs.

Take, for example, the concept of a Hilbert space. It evolved naturally as follows: To carry out the usefulness of the concept of an inner product in the study of quantum mechanics, John von Neumann introduced in 1927 the axiomatic description of a Hilbert space and used it in his work on quantum mechanics. In 1929 he was lecturing in Göttingen on these ideas. There, for the first time, he is reported to have begun his lecture by saying that a Hilbert space is a linear vector space over the complex numbers, complete in the convergence defined by the inner product and that it is also separable. David Hilbert was present in the audience sitting in the front row in the lecture hall of the Mathematische Gesellschaft. He heard this, thought a little about the definition and the axiomatic description. It is reported that he asked: Herr Dr. von Neumann, ich möchte gern wissen was ist dann eigentlich ein Hilbersche Raum? John von Neumann answered by explaining the definition.

Two of von Neumann's papers on the subject were accepted in Mathematische Annalen. When Marshall Stone saw the manuscripts he urged von Neumann to use the notion of the adjoint T^* of a linear operator T , saying that this would lead to a more effective treatment. Von Neumann got the point immediately and wanted to withdraw the papers. But they had already been set to type; Springer Verlag agreed to cancel them provided von Neumann wrote a book on the subject in their Grundlehren series. Marshall Stone knew the idea of adjoint differential operator while studying under G. D. Birkhoff on differential equations; he was thus able to see how to transfer the notion of adjoint to Hilbert spaces.

Steven Krantz discusses in his first chapter of [1] a little history how Plato's geometry influenced Euclid who lived roughly at the same time as Plato and also how Einstein benefitted from Riemann's new ideas in Riemannian geometry. He points out further how Fields' medalist John Milnor's remarkable work on a differentiable structure on the 7-sphere. The concluding section of the chapter describes how although Johannes Kepler was a student of Tycho Brahe, the latter was reluctant to share his hard-won data with Kepler. The story is told that Brahe succumbed to excessive beer-drinking and Kepler took the opportunity to negotiate with Brahe's family to obtain the much-needed data.

[1] Steven G. Krantz, *A Mathematician comes of age*, MAA 2012.

Histoire utile d'idées

Il est intéressant et formateur d'étudier l'origine et l'élaboration de notions mathématiques et de leur nom. Le tout fait partie de l'étude de l'histoire des mathématiques en général. Sans devoir forcément aller trop à fond dans l'histoire de la discipline, une connaissance partielle de la façon dont certaines idées proposées se sont développées aidera à bien saisir les sujets, les théorèmes et leurs preuves.

Prenons, par exemple, la notion d'un espace de Hilbert. Elle a évolué naturellement, comme suit : pour rendre utile la notion d'un produit intérieur dans l'étude de la mécanique quantique, John von Neumann a proposé en 1927 la description axiomatique d'un espace de Hilbert et s'est servi de cette description dans son ouvrage sur la mécanique quantique. En 1929, il donnait, à Göttingen, un exposé portant sur ces idées. Là, pour la première fois selon ce qu'on a dit, il a commencé son exposé en disant qu'un espace de Hilbert était un espace vecteur linéaire sur les nombres complexes, complet dans la convergence définie par le produit intérieur et qu'il était aussi divisible. David Hilbert était présent et assis dans la première rangée de la salle de conférences du Mathematische Gesellschaft. Il a entendu les propos du présentateur, a réfléchi un peu à la définition et à la description axiomatique. On dit qu'il a ensuite posé la question suivante : « Herr Dr. von Neumann, ich möchte gern wissen was ist dann eigentlich ein Hilbersche Raum? » John von Neumann a répondu en expliquant la définition.

Deux des articles savants de M. von Neumann à ce sujet ont été acceptés dans le Mathematische Annalen. Lorsque Marshall Stone a vu les manuscrits, il a empressé M. von Neumann d'employer la notion du T^* conjugué d'un opérateur linéaire T , car selon lui cela mènerait à un traitement plus efficace. Monsieur von Neumann a compris sur-le-champ et voulut retirer ses articles. Mais tout avait déjà été envoyé à l'imprimerie. Springer Verlag a accepté d'annuler les articles à condition que M. von Neumann rédige un ouvrage à ce sujet, ouvrage qui ferait partie de la série Grundlehren de la maison d'édition. Marshall Stone était au courant de l'idée d'un opérateur différentiel conjugué, notion qu'il avait connue pendant qu'il étudiait, sous G. D. Birkhoff, les équations différentielles; il a donc su comment transférer la notion de conjugaison aux espaces de Hilbert.

Steven Krantz décrit dans le premier chapitre de [1] comment la géométrie de Platon a influencé Euclide qui a vécu à peu près à la même époque que Platon et comment Einstein a tiré parti des nouvelles idées de Riemann en géométrie de Riemann. Il décrit aussi l'ouvrage remarquable du médaillé Fields, John Milnor, sur une structure différentiable sur la sphère 7. On décrit à la dernière section du chapitre comment, même si Johannes Kepler était un étudiant de Tycho Brahe, ce dernier hésitait à partager ses données durement obtenues avec M. Kepler. On dit que M. Brahe a succombé à une consommation excessive de bière et que M. Kepler a profité de l'occasion pour négocier avec la famille de M. Brahe afin d'obtenir les données précieuses.

[1] Steven G. Krantz, *A Mathematician comes of age*, MAA 2012.

Louigi Addario-Berry, *Vice-Président, Québec*



C'est en juin 1945 que s'est tenu le premier Congrès canadien de mathématiques à Montréal; c'est là que commence l'histoire de la Société mathématique du Canada. Cet été marque donc le début de notre 70^e année d'association porte-parole des mathématiques au Canada.

C'est aussi un été marquant pour deux autres raisons. D'abord pour la SMC, car pour la troisième fois depuis 1945, sa présidence est assurée par une femme, la professeure Lia Bronsard de l'Université McMaster, 33^e présidente de la SMC/Congrès canadien de mathématiques. Ensuite pour les mathématiques en général, puisque Maryam Mirzakhani a reçu une médaille Fields. Depuis la première remise de cette médaille en 1936, elle est la première femme médaillée sur 56 lauréats. J'aimerais profiter de cette occasion pour parler du déséquilibre hommes-femmes et de l'inégalité des structures dans le milieu des mathématiques, et particulièrement de ce que les hommes peuvent faire pour corriger ces déséquilibres. (Je ne m'attarderai pas ici à prouver l'existence de tels déséquilibres ni leur injustice, s'ils sont, par exemple, fondés sur des différences innées de capacité. Si vous vous intéressez aux preuves, je vous conseille par exemple le www.nature.com/women.)

C'est évidemment une bonne chose pour l'avancement des mathématiques que des femmes occupent des postes de direction ou jouent des rôles de mentores. Toutefois, il faut prendre conscience que nous nous attendons parfois à ce qu'une femme porte plus de chapeaux qu'un homme occupant le même poste. Si l'on suppose qu'en tant que médaillée Fields, Maryam Mirzakhani sera de facto porte-parole de la cause des femmes en mathématiques, ou qu'en plus de ses fonctions normales de présidente, Lia Bronsard devrait automatiquement participer à des initiatives de la SMC organisées spécialement pour les femmes, on leur confie alors des obligations supplémentaires, que l'on oublie sans doute souvent. Au risque d'insister, je répète que l'on ne considérerait vraisemblablement pas qu'un homme au même poste aurait les mêmes responsabilités.

C'est d'ailleurs un enjeu auquel il faudrait accorder plus d'attention de façon générale. Voici un autre exemple : en mars 2012, l'Assemblée nationale de France a adopté une loi destinée à promouvoir la parité professionnelle entre les hommes et les femmes pour combattre la discrimination. Cette loi prévoit notamment que tout organisme public doit compter au moins 40 % de femmes au sein de ses conseils d'administration, conseils publics, conseils de surveillance et comités de recrutement ou de promotion (et au moins 40 % d'hommes). Ces dispositions sont pour la plupart déjà en vigueur, mais elles ne s'appliqueront aux comités de recrutement ou de promotion qu'à compter du 1er janvier 2015.

Suite à la page 6

Letters to the Editors

The Editors of the NOTES welcome letters in English or French on any subject of mathematical interest but reserve the right to condense them. Those accepted for publication will appear in the language of submission. Readers may reach us at the Executive Office or at notes-letters@cms.math.ca

Lettres aux Rédacteurs

Les rédacteurs des NOTES acceptent les lettres en français ou anglais portant sur un sujet d'intérêt mathématique, mais ils se réservent le droit de les comprimer. Les lettres acceptées paraîtront dans la langue soumise. Les lecteurs peuvent nous joindre au bureau administratif de la SMC ou à l'adresse suivante : notes-lettres@smc.math.ca.

NOTES DE LA SMC

Les Notes de la SMC sont publiés par la Société mathématique du Canada (SMC) six fois l'an (février, mars/avril, juin, septembre, octobre/novembre et décembre).

Rédacteurs en chef

Robert Dawson, Srinivasa Swaminathan
notes-redacteurs@smc.math.ca

Rédacteur-gérant

Johan Rudnick jrudnick@smc.math.ca

Rédaction

Éducation : John McLoughlin et Jennifer Hyndman
notes-education@smc.math.ca

Critiques littéraires: Karl Dilcher
notes-critiques@smc.math.ca

Réunions : Sarah Watson
notes-reunions@smc.math.ca

Recherche : Florin Diacu,
notes-recherche@smc.math.ca

Assistante à la rédaction : Jessica St-James

Note aux auteurs : indiquer la section choisie pour votre article et le faire parvenir au Notes de la SMC à l'adresse postale ou de courriel ci-dessous.

Les Notes de la SMC, les rédacteurs et la SMC ne peuvent être tenus responsables des opinions exprimées par les auteurs.

CMS NOTES

The CMS Notes is published by the Canadian Mathematical Society (CMS) six times a year (February, March/April, June, September, October/November and December).

Editors-in-Chief

Robert Dawson, Srinivasa Swaminathan
notes-editors@cms.math.ca

Managing Editor

Johan Rudnick jrudnick@cms.math.ca

Contributing Editors

Education: John McLoughlin and Jennifer Hyndman
notes-education@cms.math.ca

Book Reviews: Karl Dilcher
notes-reviews@cms.math.ca

Meetings: Sarah Watson
notes-meetings@cms.math.ca

Research: Florin Diacu,
notes-research@cms.math.ca
Editorial Assistant: Jessica St-James

The Editors welcome articles, letters and announcements, which can be sent to the CMS Notes at the address below.

No responsibility for the views expressed by authors is assumed by the CMS Notes, the editors or the CMS.

Canadian Mathematical Society - Société mathématique du Canada
209-1725 St. Laurent Blvd., Ottawa, ON, Canada K1G 3V4 tel 613-733-2662 | fax 613-733-8994

notes-articles@cms.math.ca | www.smc.math.ca www.cms.math.ca
ISSN : 1193-9273 (imprimé/print) | 1496-4295 (électronique/electronic)

Continued from page 1

or trustees, public councils, supervisory boards, and hiring and promotion committees, must be women (and at least 40% must be men). These provisions are mostly now active; for hiring and promotion committees the law takes effect on Jan 1, 2015.

In France, a substantial percentage of scientists are CNRS researchers and are therefore public employees. However, as of 2012 only 16.5% of CNRS mathematicians are women. As the above data suggest, and multiple French colleagues confirm, this law ends up placing an inordinate burden on women in mathematics, who feel obligated to spend a disproportionate amount of their time doing committee work. Indeed, for those women mathematicians working for the CNRS, their employer will shortly be legally required to force them to do so. That initiatives to address gender imbalance in mathematics should themselves be a cause of further inequality is a stroke of tragic irony.

To a large extent, we mathematicians all want the same thing: to get on with our mathematics. I have yet to meet a mathematician of any gender who is impassioned by serving on administrative committees. I also believe that some view “just getting on with our mathematics” as an apolitical stance. However, both our actions and our inactions impinge on others, whether or not we are conscious of it.

Being aware and engaged will ultimately improve our community and improve mathematics. It is not sufficient for men to be “gender-blind” — by this I mean assessing other researchers only on their merits and paying no attention to gender — which research suggests we are actually rather bad at, in fact. The onus for addressing structural inequality within our discipline should rest upon all of us. We must not view removing the barriers to entry and advancement for women in mathematics as itself women’s work. Men in mathematics must take an active role.

New International Women In Math Website

In March 2013 the Executive Committee of the International Mathematical Union (IMU) approved the establishment of an Advisory Group for Women in Mathematics, charged with creating and overseeing a section of the IMU website entitled Women in Mathematics (WiM). Opportunities for women vary widely from country to country and a main aim is to enhance the participation of women in all mathematical communities. The new WiM site will be launched at the International Congress of Women Mathematicians on August 12th just prior to the International Congress of Mathematicians, at the address <http://www.mathunion.org/wim/>

The site includes information about organizations, people, events, resources and initiatives of interest to women mathematicians world-wide. In order to maximize the usefulness of this site, we welcome suggestions from the community. Indeed, advice concerning items for inclusion is important to us.

The Advisory Group may be contacted at info-for-wim@mathunion.org

The WiM Advisory Group: Ingrid Daubechies (Chair) (USA), Petra Bonfert-Taylor (USA), Carla Cedarbaum (Germany), Nalini Joshi (Australia), Sunsook Noh (Korea), Marie-Françoise Ouedraogo (Burkina Faso), Dušanka Perišić (Serbia), Claudia Sagastizábal (Brazil), Caroline Series (UK), and Carol Wood (USA).

McMaster University Presents

2014 CMS Winter Meeting

December 5 - 8, 2014, Hamilton Sheraton

cms.math.ca/events/winter14

Early Bird Deadline September 30

Présente l'Université McMaster

Réunion d'hiver 2014 de la SMC

5-8 décembre 2014, Hamilton Sheraton

smc.math.ca/reunions/hiver14

Date limite de pré-inscription : 30 septembre





SEPTEMBER 2014

- 7-12** Mathematics of the Cell: Integrating Genes, Biochemistry and Mechanics <http://www.birs.ca/events/2014/5-day-workshops/14w5075>
- 7-12** Workshop on Exceptional Orthogonal Polynomials & Exact Solutions in Math Physics (*Sergovia, Spain*) <http://www.icmat.es/congresos/2014/xopconf/>
- 8-12** Beyond Bioinformatics SAMSI Opening Workshop (*North Carolina Biotechnology Center, Research Triangle Park, NC*) <http://www.samsi.info/workshop/2014-15-bioinformatics-opening-workshop-september-8-12-2014>
- 12** Set Theory Seminar (*Fields Institute, Room 210*) http://www.fields.utoronto.ca/programs/scientific/14-15/set_theory/
- 15-19** Conference on Optimization, Transportation and Equilibrium in Economics (*Fields Institute*) <http://www.fields.utoronto.ca/programs/scientific/14-15/variationalprob/economics/>
- 18** 9th Annual Richard & Louise Guy Lecture: Robert Eugene Megginson, Native American Mathematics (*University of Calgary*)
- 18** Operator Algebras Seminar (*Fields Institute, Room 210*) http://www.fields.utoronto.ca/programs/scientific/14-15/operator_algebras/
- 19** PIMS/UBC Distinguished Colloquium: Alexander Lubotzky (*University of British Columbia*)
- 19** Probability on Trees and Planar Graphs (14w5159) <http://www.birs.ca/events/2014/5-day-workshops/14w5159>

SEPTEMBER CONTINUED

- 14-19** Probability on Trees and Planar Graphs <http://www.birs.ca/events/2014/5-day-workshops/14w5159>
- 21-26** Multiscale Models of Crystal Defects (HALF) <http://www.birs.ca/events/2014/5-day-workshops/14w5069>
- 21-26** Rigorously Verified Computing for Infinite Dimensional Nonlinear Dynamics (HALF) <http://www.birs.ca/events/2014/5-day-workshops/14w5098>
- 22-25** 5th International Conference on Runtime Verification (*Fields Institute, Room 230*) <http://www.fields.utoronto.ca/programs/scientific/14-15/RV2014/>
- 28-Oct 3** Vojta's Conjectures <http://www.birs.ca/events/2014/5-day-workshops/14w5129>

OCTOBER 2014

- 3-5** Atlantic Math/Stats/CS Conference (*UNB Saint John*)
- 3-5** Connecting Women in Mathematics Across Canada (*Banff International Research Station (BIRS), Banff*) <http://www.birs.ca/events/2014/2-day-workshops/14w2196>
- 9** Workshop on Big Data in Networks and Distributed Systems (*Simon Fraser University*)
- 10** Sparse Representations, Numerical Linear Algebra, and Optimization (14w5003) <http://www.birs.ca/events/2014/5-day-workshops/14w5003>

Continued on page 16

Call For Nominations: 2015 Excellence in Teaching Award Appel de candidatures: Prix d'excellence en enseignement 2015

The Canadian Mathematical Society is inviting nominations for the 2015 Excellence in Teaching Award. The CMS encourages you, as someone with an interest in the Canadian mathematical community, to consider nominating an associate for this award.

The Excellence in Teaching Award is the only national award specifically for post-secondary mathematics teaching. The Award focuses on the recipient's proven excellence as a teacher as exemplified by unusual effectiveness in the classroom and commitment and dedication to teaching and to students.

The CMS is proud to partner with Nelson Education to present this award. As Canada's largest educational publisher, Nelson delivers an unrivalled learning advantage to enable the success of Canadian students and educators.

The deadline for nominations is **November 15, 2014**. Complete nomination details are available at: <http://cms.math.ca/Prizes/et-nom>

La Société mathématique du Canada (SMC) lance une invitation de mise en candidature pour le Prix d'excellence en enseignement 2015. La SMC vous invite, en votre qualité de président de votre faculté, à envisager de proposer la candidature d'un collègue pour ce prix.

Le Prix d'excellence en enseignement est le seul prix national s'adressant tout particulièrement à l'enseignement des mathématiques à un niveau postsecondaire. Le prix souligne l'excellence démontrée du lauréat comme enseignant, comme le témoigne son efficacité inhabituelle en salle de classe et son engagement à l'enseignement et aux étudiants.

La SMC est fière de former un partenariat avec Nelson Education afin de remettre ce prix. À titre d'une des plus importantes maisons d'édition de matériel d'enseignement au Canada, Nelson offre un avantage sans pareil en matière d'enseignement afin d'assurer le succès des étudiants et des enseignants canadiens.

La date d'échéance pour les candidatures est le **15 novembre 2014**. On peut obtenir les détails complets de la mise en candidature à l'adresse suivante : <http://cms.math.ca/Prix/et-nom>

Suite de la page 3

En France, une forte proportion de scientifiques sont des chercheurs du CNRS et donc des employés de la fonction publique. En 2012, toutefois, seulement 16,5 % des mathématiciens du CNRS étaient des femmes. Comme on peut l'imaginer d'après cette statistique et comme le confirment plusieurs collègues françaises, cette loi impose un fardeau supplémentaire substantiel aux mathématiciennes, qui se sentent obligées de consacrer un nombre d'heures disproportionné aux travaux de comités. Et pour ces mathématiciennes qui travaillent au CNRS, leur employeur aura très bientôt l'obligation de les forcer à le faire. Bref, ces initiatives visant à corriger le déséquilibre entre les sexes en mathématiques finissent plutôt par accentuer le déséquilibre. Quelle ironie!

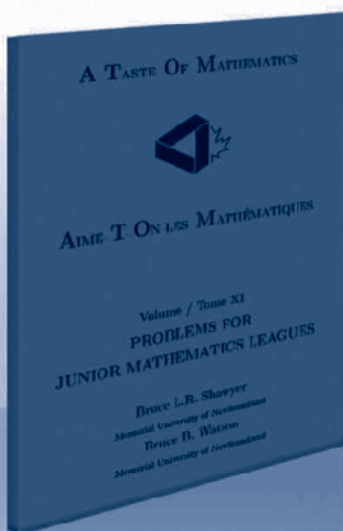
Dans une large mesure, nous voulons tous la même chose en tant que mathématiciens, soit nous consacrer aux mathématiques comme telles. Je n'ai pas encore à ce jour rencontré de mathématicien passionné de siéger à un comité d'administration.

Je crois aussi que pour certains, « se consacrer aux mathématiques comme telles » est une position apolitique. Toutefois, nos actions tout comme nos inactions ont des répercussions sur notre entourage, que nous en soyons conscients ou non.

Par la prise de conscience et l'engagement, nous finirons ensemble par améliorer notre communauté et, par ricochet, à faire avancer les mathématiques. Il ne suffit pas pour les hommes de ne pas tenir compte du sexe des gens – j'entends par là le fait d'évaluer d'autres chercheurs uniquement d'après leurs atouts sans tenir compte de leur sexe –, ce que nous ne parvenons pas à bien faire de toute façon, selon certaines études. Il nous revient à tous de redresser les inégalités structurelles de notre discipline. Il ne faut pas considérer qu'il revient uniquement aux femmes d'éliminer les obstacles bloquant l'accès des femmes aux mathématiques et nuisant à leur progression dans la profession. Les hommes doivent aussi jouer un rôle actif dans cette démarche.



Figure 1 Photo prise au premier Congrès canadien de mathématiques en 1945 (voir <http://cms.math.ca/Historical/1945/>). Même avec la liste des inscriptions, nous ne sommes pas parvenus à identifier la plupart des personnes figurant sur cette photo. Nous avons retrouvé M. Von Neumann (rangée du bas, deuxième à partir de la droite), mais pas M. Birkhoff, qui y était pourtant aussi.



SAVE ON ATOM SET! EPARGNEZ SUR LA SÉRIE ATOM!

Purchase the set

A Taste of Mathematics (ATOM) Volumes 1 to 13
and receive a **10% discount!**

Acheter la série

Aime-T-On les Mathématiques (ATOM) Tome 1 à 13
et épargner un **rabais de 10%!**

Order your ATOM set today at www.cms.math.ca

Commander votre série ATOM aujourd'hui au www.cms.math.ca

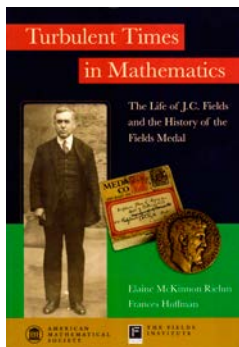
Turbulent Times in Mathematics: The Life of J.C. Fields and the History of the Fields Medal

by Elaine McKinnon Riehm and Frances Hoffman

AMS 2011

ISBN 978-0-8218-6914-7

Reviewed by *Peter Fillmore, Dalhousie University*



In 1914 the international mathematical community, which had met in congress several times, beginning in 1893 in conjunction with the World's Columbian Exposition in Chicago, was torn asunder by war. Passionate animosity, especially between many German and French mathematicians, including luminaries like Felix Klein and Emile Picard, meant that for some years it would be impossible to hold a congress that included representatives of both these nations. In December 1918

French and Belgian mathematicians decided that the 1920 congress would take place in Strasbourg, France, and would exclude Germany and her allies. The choice of Strasbourg was deliberate: it had been seized by Germany in 1870 but would be returned to France in the peace agreement of 1919. At this congress the International Mathematical Union was founded, again excluding Germany and her allies; and the invitation of L.E. Dickson, to hold the 1924 Congress in the United States, was accepted. Dickson's intention was that the Congress would be truly international, but as it became clear that this would be impossible, turmoil erupted in the American Mathematical Society (AMS). Into this situation stepped J.C. Fields, offering to host the Congress in Toronto. Who was this intrepid man?

Fields was born in Hamilton in 1863 and entered the University of Toronto in 1881. The enrolment was 350 and the Department of Mathematics and Natural Philosophy comprised three members. He went on to Johns Hopkins for his PhD, completed in 1887, where the department head was astronomer Simon Newcomb (born in Nova Scotia). His growing interest in research led him to Europe for further study in 1892. He spent two years in Paris, but it was his five years in Germany, mostly in Berlin, that had the greatest impact. What struck him was the way German universities were organized to give primacy to research. There was intellectual liberty and the pursuit of truth for its own sake. Returning to Canada in 1900, he spent the winter at the University of Chicago, where E.H. Moore was lecturing on Hilbert's "Zahlbericht". He then began

"Soon afterwards Fields set to work, doggedly and tirelessly, to organize the 1924 congress, buttonholing businessmen and politicians (including the Prime Minister, Mackenzie King) for money"

teaching at Toronto, but continued to travel extensively and to meet many of the world's leading mathematicians. During the following years Fields's activities were driven by his passion for research, both his own and for Canadian science generally. He published papers and a research monograph, and became active in the Royal Society of Canada and the Royal Canadian Institute, serving for a number of years as president of the latter and pressing for the establishment of research facilities in Canada. He chaired the local committee for the 1921 meeting of the American Association for the Advancement of Science in Toronto; its great success was largely due to his hard work.

Soon afterwards Fields set to work, doggedly and tirelessly, to organize the 1924 congress, buttonholing businessmen and politicians (including the Prime Minister, Mackenzie King) for money, twisting the arms of friends and colleagues for help, and globe-trotting to drum up interest in attending. He accepted that government support (essential for travel subventions for overseas mathematicians) would not be forthcoming if the French boycotted the meeting, and that therefore the Germans could not be invited. But the great boost that Canadian mathematics would receive would make this acceptable. However there were consequences: for example no Finns attended, and the London Mathematical Society refused to send an official delegation (G.H. Hardy did not come). In the event, 444 mathematicians from 33 countries attended, and Fields felt his optimism had been justified.

The next task for Fields was to see to the financing and preparation of the Congress proceedings. This turned out to be a big job, but the two sumptuous volumes were published, finally, in 1928, and he was then free to turn his attention to a project he had perhaps had in mind for some time: the creation of an international medal to recognize outstanding work in mathematics. Such an award would support research and would help close the rift in the mathematical world, both of which goals were near to his heart. Again he travelled extensively to drum up support for the idea, first obtaining the approval of the AMS, followed by the principal mathematical societies of Europe. His proposal was accepted at the 1932 congress in Zurich. But Fields had died earlier in the year and it was left to his Toronto colleague J.L. Synge to complete the final details. Fields had stipulated that the name of no individual or country should be attached to the medal but, perhaps inevitably, it became known as the Fields Medal.

In broad outline, the story of Fields and his medal has been known to mathematicians (if not to the general public) for many years. But the authors of the present volume have, evidently, worked doggedly and tirelessly--like Fields himself--to bring us a wealth of additional detail, from the minutiae of daily life in Hamilton when Fields was growing up there, to the grand themes of the Great War and its impact on mathematics. Among the several appendices to the book are brief biographies of the Fields medallists and Fields's colleagues and friends, and a list of credits for the 55 photos included in the volume. Riehm and Hoffman have told the story thoroughly and absorbingly, and deserve our thanks.

Editor's note: Just before press time, the 2014 Fields Medalists were announced, among them the Princeton number theorist Manjul Bhargava. Like Fields, Bhargava was born in Hamilton!

Jennifer Hyndman, *University of Northern British Columbia*
John McLoughlin, *University of New Brunswick*

A primary role of Education Notes concerns bringing mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, and noteworthy news items. This issue brings together pieces from each of these areas.

The theme of mathematical outreach remains at the forefront in the 2014 Education Notes, an effort on the part of the editors to bring attention to this natural bridge with mathematics and education. As this year winds down, the co-editors invite suggestions for a theme to highlight in 2015. Of course, we welcome receiving submissions from unexpected sources such as the report that appears in this issue. We are grateful to Chantal Buteau for bringing this work to our attention. Please send us along ideas and information about activities or news in your area.

About Your Use of Computer Algebra Systems (CAS) in University Teaching: A Canadian Survey

Chantal Buteau (*Brock University*),
Daniel Jarvis (*Nipissing University*), and
Zsolt Lavicza (*University of Cambridge, UK*)

In Spring 2009, mathematicians working in a department of mathematics at a Canadian University or at a CEGEP (in Quebec) received an email invitation to participate in an online survey about the extent of Computer Algebra Systems (CAS) use in their post-secondary instruction. Despite some difficulties reaching all intended participants (e.g., some e-mails were wrongly identified by institutional servers as spam, and therefore some mathematicians did not receive the invitation), 302 mathematicians responded to the invitation and completed the survey either in English (N=223) or in French (N=79). This study can be viewed as an extension (or part) of an international study by Lavicza (2008) involving mathematicians in the UK, USA, and Hungary. A detailed report of the survey results has now been published in the *Canadian Journal of Mathematics, Science and Technology Education*, but in the following we summarize for you some of the main results using excerpts from the paper by Buteau, Jarvis, and Lavicza (2014). If you wish to view the survey questionnaire (in French or English), please refer to the following webpage: <http://casresearch.nipissingu.ca/canadiansurvey.htm>

Results suggest that a considerable number of Canadian mathematicians use CAS in research and teaching (see Figure 1).

CAS use in research was found to be the strongest factor affecting CAS integration in teaching (i.e., as opposed to gender, research area, or age). In addition, our study suggests that mathematicians believe that CAS is becoming an integral part of contemporary mathematics knowledge. Two main factors impeding CAS integration were identified as the departmental culture and the time required for designing CAS-based resources. Mathematicians mostly reported incorporating CAS use into assignments, and much less for in-class tests and final examinations. CAS integration in teaching appears to remain a predominantly individual initiative. Overall results from the Canadian survey were similar to those of the international survey study. Finally, our study also asked participants about the use of different digital technologies in teaching and research. The results point to two particularly interesting observations: (a) CAS

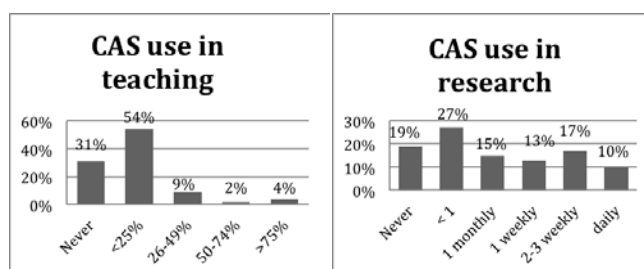


FIGURE 1. To the left, use of CAS in teaching: "In a typical academic term, in approximately what percentage of your lessons do you use CAS?"; to the right, use of CAS in research "In an average working month, how frequently do you use CAS in your research?"

seems to be the most used mathematics technology by Canadian mathematicians in teaching and in research; and (b) the second most used technology by Canadian mathematicians in their research seems to be programming technology, whereas this particular technology seems to be integrated in their teaching to a relatively much smaller extent than other mathematics technologies (e.g., dynamical geometry software, statistical analysis software, discrete math software).

Buteau, C., Jarvis, D. H., & Lavicza, Z. (2014). On the integration of Computer Algebra Systems (CAS) by Canadian mathematicians: Results of a national survey. *Canadian Journal of Science, Mathematics and Technology Education*, 14(1), 35-57.

Mathematics and Outreach: Some Notes from British Columbia

contributed by **John McLoughlin**

The mathematical community in British Columbia celebrates mathematics in many ways. Typically one week in May consists of a range of mathematical activities. This year I had the opportunity to participate in the activities during the week of May 12-16, 2014. My notes and reflections on some of the highlights of this experience are shared here. The concluding piece is a tribute to this year's recipient of the PIMS Education Prize, Susan Milner.

BC Secondary School Math Contest

The week begins annually with Monday set aside for drafting the BC Secondary School Math Contest, an effort organized by Clint Lee of Okanagan College for the past 20 or so years. About a dozen people drop in over the day to begin compiling a collection of problems that



will provide a basis for opening drafts of the contests. Clint coordinates the subsequent electronic discussions and contributions of junior and senior contest committees over the course of the next eight months or so to prepare preliminary and final round papers for both Junior (Grades 8-10) and Senior (Grades 11 and 12) contests. The finals are held in numerous locations around BC at the start of May. Preparations for the 2015 contests will mark Clint's final year in that role. Hats off to Clint Lee for such outstanding leadership!

Preliminary and final papers from 1999 to 2014 inclusive, along with more details on the contest are available at this link: <http://people.okanagan.bc.ca/clee/bcssmc/>

Changing the Culture

The week wrapped up on Friday with Changing the Culture (an annual event organized by Malgorzata Dubiel and hosted by SFU). This year's conference was dedicated to Katharine Borgen who passed away earlier this year. Katharine was a long time teacher who cared deeply about mathematics education while participating in the math community. More information on this conference going back to its origins in 1998 appear at the PIMS site:

<http://www.pims.math.ca/educational/changing-culture>

Sharing Mathematics

An annual event, *Sharing Mathematics*, was held on May 15, 2014 at Kwantlen Polytechnic University. The gathering follows the two-day articulation meeting of the BC Undergraduate Programmes Mathematics and Statistics each May. (See www.bccupms.ca for more information on the group and the meetings)

Sharing Mathematics grew out of an initial effort to honour Jim Totten in Kamloops in 2009, and has become a mainstay of the week in May. This year's organizers were Susan Milner and Jim Bailey, both of whom this past year individually authored feature articles in *Education Notes*.

Certainly the most memorable portion of the day was the opening workshop on *Hexastix* facilitated by Veso Jungic. The experience of using pencils to create these curious geometrical configurations took me out of my comfort zone. The camaraderie and playfulness among colleagues was a joy to behold. The photo gallery at the link below offers a window into this spirit.

<http://mathcatcher.irmacs.sfu.ca/workshops/sharing-mathematics-conference>

The end of the day was curious as several of us wandered back with the *Hexastix* models to the hotel. We arrived simultaneously alongside a group of high school students there with a school band. The reaction caught me by surprise as they were in awe and wondered how they could make those for their math teachers.

Congratulations to Susan Milner

Susan Milner is the recipient of the 2014 PIMS Education Prize. This prize, awarded annually, recognizes individuals in Western Canada and Washington State who have played a major role in encouraging activities which have enhanced public awareness and appreciation of mathematics, as well as fostering communication among various groups concerned with mathematical education at all levels. Susan is a faculty member in the Department of Mathematics and Statistics of the University of the Fraser Valley (UFV).

The honour reflects Susan's commitment to math outreach along with her interests in math education. The latter led her to become an active member of the BC Committee on Undergraduate Programs in Mathematics and Statistics, where she served as Chair of the Committee for six years (2002–2008). Her interest and expertise in popularizing mathematics led her to bring PIMS *Math Mania* to schools in the Fraser Valley. Since 2007 she (often accompanied by her team of UFV colleagues and student volunteers) has visited scores of schools including 39 during a sabbatical in 2012/2013. These visits have inspired some of the schools to organize their own *Math Mania* events. UFV has recognized Susan's outreach work by awarding her the 2013 Dean of Science Awesome Achievement Award in the Outstanding Outreach category.

But Susan did not simply "transplant" *Math Mania* to the Fraser Valley. She has enhanced and enriched it by adding many of her own favourite activities, including origami and puzzles. Using puzzles to teach mathematics and to attract people to mathematics has been one of Susan's passions. She writes about her "love affair" with mathematical puzzles, with comments on how can one use puzzles in a classroom, in the article *Puzzles in my Life*, which appeared in CMS Notes (<http://cms.math.ca/notes/v45/n5/Notesv45n5.pdf>) Susan has also given workshops at Science World and several workshops for teachers from various schools and school districts.

Alejandro Adem, PIMS Director, remarked, "Susan Milner is an outstanding educator, who has worked tirelessly to share the joy of mathematics with countless students and teachers in BC. This prize recognizes her wonderful achievements and selfless dedication to mathematics."

The 2014 PIMS Education Prize, sponsored by Hampson-Russell/CGG, was awarded at the annual *Changing the Culture Conference* organized by PIMS in Vancouver, on Friday, May 16, 2014.

Note: The information on the PIMS Education Prize has been adapted from the announcement on the PIMS website. Those interested in knowing more about Math Mania may wish to refer to the most recent June 2014 Education Notes where it is described in some detail by Melania Alvarez.

Combinatorial Hopf Algebra and Positivity

Nantel Bergeron, *Department of Mathematics and Statistics, York University*

Combinatorial objects can often be combined to build up more intricate structures or decomposed into simpler ones. Enumeration and classification of these structures can give rise to a graded Hopf algebra where multiplication and comultiplication encode association and decomposition of the combinatorial objects [4]. We call such structure a combinatorial Hopf algebra. They often carry information that relates to other areas of science, including computer science and physics. For example, in physics, Connes and Kreimer [2] showed that a Hopf algebra of rooted trees efficiently encodes renormalization in quantum field theory. Using this Hopf algebra structure, they show how to factor the theoretical energy potential of interacting particles in order to obtain the measured energy of the system (renormalization). In computer science, Mulmuley [7] has a program studying the level of complexity of algorithms (P vs P). In his program, one needs to give a positive combinatorial construction of certain constants. Of interest for this program is a construction of the Littlewood-Richardson coefficients [5], which are instances of structure constants of the combinatorial Hopf algebras of symmetric functions.

To get a better sense of this, let us consider the space of formal power series $\mathbb{Q}[[x_1, x_2, \dots]]$. A typical element $f(x_1, x_2, \dots) \in \mathbb{Q}[[x_1, x_2, \dots]]$ has the form

$$f(x_1, x_2, \dots) = \sum_{\alpha=(\alpha_1, \alpha_2, \dots)} c_\alpha x_1^{\alpha_1} x_2^{\alpha_2} \dots$$

where the sum is over all infinite vectors α of nonnegative integers such that $\sum \alpha_i < \infty$. We are interested in the subspace of symmetric functions $\text{Sym} \subset \mathbb{Q}[[x_1, x_2, \dots]]$. This is the subspace of bounded degree series that are invariant under any permutation of the variables. Newton shows that Sym is in fact the polynomial ring $\mathbb{Q}[h_1, h_2, \dots]$ where

$$h_k(x_1, x_2, \dots) = \sum_{\substack{\alpha=(\alpha_1, \alpha_2, \dots) \\ \sum \alpha_i = k}} x_1^{\alpha_1} x_2^{\alpha_2} \dots = \sum_{i_1 \leq i_2 \leq \dots \leq i_k} x_{i_1} x_{i_2} \dots x_{i_k}.$$

Sym is a graded Hopf algebra and as we will see below, it is a combinatorial Hopf algebra. The multiplicative structure is given by the usual multiplication in $\mathbb{Q}[h_1, h_2, \dots]$ with $\text{deg}(h_k) = k$ and the comultiplicative structure given by $\Delta(h_k) = \sum_{i=0}^k h_i \otimes h_{k-i}$ is extended algebraically to all of Sym . Here we set $h_0 = 1$ for convenience.

Bases of Sym are naturally indexed by the integer partitions $\lambda = (\lambda_1, \dots, \lambda_\ell)$ where $\ell \geq 0$ and $\lambda_1 \geq \dots \geq \lambda_\ell > 0$. The most important basis of Sym is the set of Schur functions $s_\lambda = \det [h_{\lambda_i + j - i}]_{1 \leq i, j \leq \ell}$, where $h_k = 0$ for $k < 0$. The Schur functions appear throughout mathematics: as the representatives for the Schubert classes in the cohomology

of the Grassmannian [3]; as the characters for the irreducible representations of the symmetric group and of the general linear group [6,8]; as a self-adjoint orthonormal basis for the algebra of symmetric functions [10]; and many more. The ubiquitousness of the Schur basis makes it an object of central importance in the theory of symmetric functions. It is also singled out as the unique basis of Sym with all those properties.

In order to explore some of this combinatorics, notice that when we expand a Schur function s_λ in the monomials $x_1^{\alpha_1} x_2^{\alpha_2} \dots$, we obtain a positive expression. For example

$$s_{(2,1)} = h_1 h_2 - h_3 = \sum_{\substack{a \\ b \leq c}} x_a x_b x_c - \sum_{a \leq b \leq c} x_a x_b x_c = \sum_{a > b \leq c} x_a x_b x_c.$$

This is not an accident. Schur functions in general can be written as a positive sum over combinatorial objects by means of Young tableaux which we explore now. Given a partition $\lambda = (\lambda_1, \dots, \lambda_\ell)$, we define $D_\lambda = \{(i, j) \in \mathbb{Z} \times \mathbb{Z} : 1 \leq j \leq \ell, 1 \leq i \leq \lambda_j\}$. A Young tableau of shape λ is a map $T: D_\lambda \rightarrow \mathbb{N}$ such that $T(i, j) \leq T(i + 1, j)$ and $T(i, j) < T(i, j + 1)$ wherever T is defined. It is useful to picture a Young tableau T as follows. In the plane, we draw a unit square in position (i, j) for each $(i, j) \in D_\lambda$. Then we write the value $T(i, j)$ inside the square (see below). Such a filling is a Young tableau if the entries are weakly increasing in rows and strictly increasing in columns. The following are examples of Young tableaux for the partition $\lambda = (3, 2)$.



This allows us to write the general formula for Schur functions:

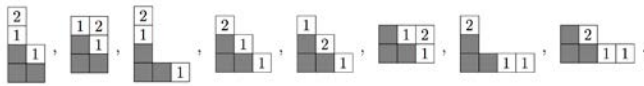
$$s_\lambda = \sum_{T: D_\lambda \rightarrow \mathbb{N}} \prod_{(i,j) \in D_\lambda} x_{T(i,j)}$$

where the sum is over Young tableaux. In view of this, it is natural to see Schur function as a weighted enumeration of Young tableaux of shape λ . That understanding plays a major role in the various interpretations of Schur functions. The combinatorics of Young tableaux has implications in geometry and representation theory. The Littlewood-Richardson rule is an explicit combinatorial expansion for the product of two Schur functions. The constants $c_{\lambda, \mu}^\nu$ in the expansions

$$s_\lambda s_\mu = \sum_\nu c_{\lambda, \mu}^\nu s_\nu, \quad \text{or} \quad \Delta(s_\nu) = \sum_{\mu, \lambda} c_{\lambda, \mu}^\nu s_\lambda \otimes s_\mu,$$

are described explicitly as the cardinality of the following constructed set. A word w over the alphabet $\{1, 2, \dots\}$ is said to be *Yamanouchi* if for every suffix of w , the number of occurrences of j is greater than or equal to the number of occurrences of $j + 1$, for all j . The *reading word* of a tableau is the word formed by reading each row from left to right, starting from the top row and moving down. In this way $c_{\lambda, \mu}^\nu$ is the number of

tableaux $T: D_\nu \setminus D_\lambda \rightarrow \mathbb{N}$ whose reading word is a Yamanouchi word with μ_i letter i . For example, the product $s_{21}s_{21} = s_{2211} + s_{222} + s_{3111} + 2s_{321} + s_{33} + s_{411} + s_{42}$. The coefficients correspond to the following tableaux



Being able to construct combinatorially these constants gives us a much deeper understanding of these coefficients. This has implications in several areas of mathematics since the multiplication and comultiplication correspond to operations in geometry and in representation theory. It is unique among the bases of Sym that the same constants describe the multiplication and the comultiplication of Schur functions.

References

[1] A. D. Berenstein and A. V. Zelevinsky, Tensor product multiplicities and convex polytopes in partition space, *J. Geom. Phys.* 5, 3 (1988), 453–472.

[2] A. Connes, D. Kreimer, Renormalization in quantum field theory and the Riemann-Hilbert problem I: the Hopf algebra structure of graphs and the main theorem, *Commun. Math. Phys.* 210 (2000), 249–273.

[3] W. Fulton, *Young Tableaux: With Applications to Representation Theory and Geometry* (Cambridge University Press), 1997.

[4] S. Joni and G.-C. Rota, Coalgebras and bialgebras in combinatorics, *Stud. Appl. Math.* 61 (1979), 93–139.

[5] A. Knutson and T. Tao, The honeycomb model of $GL_n(\mathbb{C})$ tensor products I: Proof of the saturation conjecture, *J. Amer. Math. Soc.* 12 (1999), 1055–1090.

[6] I. G. Macdonald, *Symmetric Functions and Hall Polynomials*, 2nd ed., Oxford University Press, 1995.

[7] K. D. Mulmuley, On P vs. NP and Geometric Complexity Theory, *J. ACM*, 58, 2 (2011) Art5, 25 p.

[8] B. Sagan, *The Symmetric Group: Representations, Combinatorial Algorithms, and Symmetric Functions*, 2nd ed., Springer-Verlag, New York, 2001.

[9] Richard P. Stanley, *Enumerative combinatorics*. Vol. 2, vol. 62 of Cambridge Studies in Advanced Mathematics. Cambridge University Press, Cambridge, 1999.

[10] A. V. Zelevinsky, *Representations of finite classical groups: a Hopf algebra approach*, Springer Lecture Notes, 869 (1981).

Dr. Garth H. M. Thomas
1926 -2014

Garth Thomas, a long-time esteemed member of the CMS, passed away this spring as a result of a stroke.

Garth Thomas’s contribution to the Canadian mathematical community cannot be overstated.

Garth joined the Department of Mathematics at the University of Saskatchewan in 1952 after obtaining his B.Sc. (Manitoba), his M.Sc. and Ph.D. (Wisconsin). At that time, the Department was in its infancy, comprising only six faculty members.

Garth became Full Professor in 1968 and Department Head in 1970, by which time the Department had grown to 26 members. As Head of the Department, Garth was understanding and considerate of the welfare of his colleagues. Always ready to serve, he was President of the University of Saskatchewan Faculty Association for a term.

Garth was instrumental in promoting the interest and love of mathematics among high school and undergraduate students. He started the Saskatchewan Mathematics Contests, served on the Board, and was Chairman of the Canadian Mathematics Olympiad.

As one of the founding members of the Saskatchewan Mathematics Teachers’ Society, Garth used his influence to promote raising the standard of teaching and qualifications of high school mathematics teachers. To that effect, he served on many provincial curriculum advisory committees of the Saskatchewan Department of Education.

His excellence as a teacher was renowned. He was held in great esteem by his undergraduate as well as graduate students. Many of these he encouraged to pursue careers in the mathematical sciences.

Garth generously endowed both the University of Brandon and the University of Saskatchewan for providing scholarships to students in the College of Arts and Sciences.

Garth led a full and active life. He was an avid reader, played piano very well and could still be seen on the tennis court at age 78. Garth was devoted to his widowed mother and only after she passed away did he become a married man. Through his wife Iris and his first wife Dodie, he acquired a loving extended family, which he enjoyed greatly.



Interested in **Math Community**? So is the CMS!
Check out: <http://cms.math.ca/Community/>

Applications of Harmonic Analysis to the Theory of Cardinal Invariants

Juris Steprāns, *Department of Mathematics and Statistics, York University*

The Baire Category Theorem raises an obvious question: If the intersection of countably many dense open subsets of \mathbb{R} is non-empty, what can be said about intersections of larger families? It is obvious that it is too much to ask that the intersection of 2^{\aleph_0} dense open subsets of \mathbb{R} be non-empty, but what about just \aleph_1 dense open sets? Assuming the Continuum Hypothesis, this strengthening of the Baire Category Theorem is still false, but it turns out that this cannot be established without appealing to some extra axiom, such as the Continuum Hypothesis. In other words, it has been shown to be consistent with the usual axioms of mathematics (formulated in any way one likes) that a stronger version of the Baire Category Theorem holds, one that asserts that the intersection of \aleph_1 many dense open subsets of \mathbb{R} is non-empty. Given this, it is natural to identify the least cardinal number κ such that the intersection of κ many dense open subsets of \mathbb{R} is empty and give it a name — $\mathbf{cov}(\mathcal{M})$ is often used to denote this cardinal. Baire showed that $\mathbf{cov}(\mathcal{M}) \geq \aleph_1$ and we now know that it is consistent that $\mathbf{cov}(\mathcal{M}) = \aleph_2$ and, indeed, any reasonable value is consistent with the rest of mathematics.

The cardinal number $\mathbf{cov}(\mathcal{M})$ is just one of many cardinal invariants of the continuum that have been defined and studied extensively. (The reader interested in learning more about this subject is encouraged to consult [1]). The cardinal invariant on which this brief note will focus is $\mathbf{non}(\mathcal{N})$, the least cardinal of a non-measurable subset of \mathbb{R} . Of course, $\mathbf{non}(\mathcal{N}) \geq \aleph_1$ but it can also be larger.

An innocent question that leads to an interesting connection between set theoretic techniques and harmonic analysis is the following:

Question 1. Does the inequality $\mathbf{non}(\mathcal{N}) > \aleph_1$ imply that the union of any \aleph_1 lines in the plane is measurable (and, hence, null since $2^{\aleph_0} > \aleph_1$ in this context)?

In other words, does knowing that every set of points on the real line of cardinality \aleph_1 is null imply that the union of any \aleph_1 lines in the plane is null?

The converse of this easily follows from Fubini’s Theorem. Given $X \subseteq \mathbb{R}$ of cardinality \aleph_1 let \mathcal{L} be the family of all lines passing through X and perpendicular to the x -axis. Then \mathcal{L} also has cardinality \aleph_1 and, hence, is null and so are most of its horizontal sections. But even just one horizontal section being null yields that X is null. Of course, this argument cannot be run backwards without knowing that the union of the lines is measurable. Nevertheless, it is easy to see that if every set of points on the real line of cardinality \aleph_1 is null then the union of any \aleph_1 lines in the plane perpendicular to the x -axis is also null. Since families of lines that are not all parallel will have intersections, and hence take up space less efficiently, one might be encouraged by this observation to try to establish an affirmative

answer to Question 1. As will be seen, though, this is not possible. Before dealing with Question 1 however, it is worth mentioning some related results.

Theorem 1. [7] *It is consistent with the rest of mathematics that $\mathbf{non}(\mathcal{N}) > \aleph_1$ yet there are \aleph_1 planes in \mathbb{R}^3 whose union is not null.*

Theorem 2. [7] *It is consistent with the rest of mathematics that $\mathbf{non}(\mathcal{N}) > \aleph_1$ yet there are \aleph_1 spheres of dimension $k - 1$ in \mathbb{R}^k whose union is not null.*

As with almost all results of this type, these theorems are proved by an iterated forcing construction of the required model of mathematics. The details will not be discussed here except to say that the general strategy is to iteratively add, for each $X \subseteq \mathbb{R}$ of cardinality \aleph_1 , a sequence of open sets of measure decreasing to 0 each of which contains X . This is not too difficult and will achieve that $\mathbf{non}(\mathcal{N}) > \aleph_1$. The hard part is to show that, in the case of Theorem 1, there are \aleph_1 planes in \mathbb{R}^3 whose union is not null and, in the case of Theorem 2, there are \aleph_1 spheres of dimension $k - 1$ in \mathbb{R}^k whose union is not null. This is the point at which results from harmonic analysis come into play; in particular, the boundedness of certain maximal operators is central to these arguments.

For example, Theorem 1 depends on the following result of Marstrand [4], generalized by Falconer [3] to higher dimensions.

Theorem 3. *If $X \subseteq \mathbb{R}^3$ is Lebesgue null then for almost all directions θ , all planes perpendicular to θ intersect X on a planar null set. The measure on directions is, of course, the rotation invariant measure on the surface of the 3-sphere.*

While this can be rephrased as a result on the boundedness of a certain maximal operator, the technical details obscure the key idea and are not needed at this point. However the following theorem, due to Stein [6] for $n > 2$ and Bourgain [2] for $n = 2$, is more easily stated as one about maximal operators.

Theorem 4. *If $n \geq 2$ and $p > n/(n - 1)$ and σ is the rotation invariant measure on the surface of the n -sphere and M is the maximal operator on $L_p(\mathbb{R}^n)$ defined by*

$$M(f)(x) = \sup_{t>0} \left| \int f(x - ty) d\sigma(y) \right|$$

then there is a constant c such that $\|M(f)\|_p \leq c\|f\|_p$ for all $f \in L_p(\mathbb{R}^n)$.

However, Theorem 4 does not extend to $n = 1$ as can be seen by considering Besicovitch’s construction of a Kakeya set, on which the operator M of Theorem 4 would require $c = \infty$. It turns out that this is the reason that an answer to Question 1 is not provided by the methods of [7], in spite of the fact that Theorems 1 and 2 provide answers to very similar questions.

However, the introduction to [7] does provide a geometric argument showing that the earlier results of [5] yield a negative answer to Question 1. Cardinal invariants are also the focus of [5]. If $0 \leq r \leq 1$ let \mathfrak{n}_r be the least cardinality of a set of reals that is not null with respect to Hausdorff r -measure. The main result of [5]

is that it is consistent that $\mathfrak{n}_1 > \mathfrak{n}_r$ — in other words, it is consistent that every set of reals of cardinality \aleph_1 is a Lebesgue null set, yet there are sets of reals of cardinality \aleph_1 that are not null with respect to Hausdorff r -measure. It is not known if the result on the consistency of $\mathfrak{n}_1 > \mathfrak{n}_r$ can be extended to $\mathfrak{n}_s > \mathfrak{n}_r$ for some $s \neq 1$. So one can ask if, provided that $0 < r < s < 1$, it follows that, if every set of reals of cardinality \aleph_1 is null with respect to Hausdorff s -measure, then it is also true that every set of reals of cardinality \aleph_1 is null with respect to Hausdorff r -measure.

There are many more theorems on bounded maximal operators than those mentioned here. Some of these can be used to obtain consistency results similar to Theorems 1 and 2 but others can not. Finding ways to use these other results on maximal operators may solve some further questions that arise when considering Question 1. For example, for which m and n is it true that, if the union of any \aleph_1 spheres in \mathbb{R}^n is null, then the same holds for the union of any \aleph_1 spheres in \mathbb{R}^m ? One can ask a similar question about planes in \mathbb{R}^n and whether knowledge about the measure of unions of \aleph_1 planes yields knowledge about unions of \aleph_1 spheres or conversely. Answers to these questions about cardinal invariants could have consequence in harmonic analysis through the following strategy. Prove a positive result showing two cardinal invariants equal. Then show that if a certain maximal operator were to be bounded, it would yield the consistency of the two cardinal invariants being different,

as in Theorems 1 or 2. This contradiction would then establish the unboundedness of the maximal operator in question.

References

- [1] Andreas Blass. Combinatorial cardinal characteristics of the continuum. In *Handbook of set theory*. Vols. 1, 2, 3, pages 395–489. Springer, Dordrecht, 2010.
- [2] J. Bourgain. Averages in the plane over convex curves and maximal operators. *J. Analyse Math.*, 47:69–85, 1986.
- [3] K. J. Falconer. Continuity properties of k -plane integrals and Besicovitch sets. *Math. Proc. Cambridge Philos. Soc.*, 87(2): 221–226, 1980.
- [4] J. M. Marstrand. Packing planes in \mathbf{R}^3 . *Mathematika*, 26(2): 180–183 (1980), 1979.
- [5] Saharon Shelah and Juris Steprāns. Comparing the uniformity invariants of null sets for different measures. *Adv. Math.*, 192(2):403–426, 2005.
- [6] Elias M. Stein. Maximal functions. I. Spherical means. *Proc. Nat. Acad. Sci. U.S.A.*, 73(7):2174–2175, 1976.
- [7] Juris Steprāns. Maximal functions and the additivity of various families of null sets. *Trans. Amer. Math. Soc.*, 364(7):3555–3584, 2012.

CMS Member Profile

Richard Hoshino

Home: Quest University Canada, Squamish, BC

Research: Scheduling Optimization, Graph Theory

CMS Membership: Joined CMS in 1996 right after graduating from high school.

Select Achievements: First mathematician hired in the history of the Canada Border Services Agency (2006-2010), post-doctoral fellow at the National Institute of Informatics in Tokyo (2010-2013); served as the math consultant to three Canadian TV game shows (Qubit, Splatalot, Spin-Off) as well as the Nippon Professional Baseball league in Japan.

Hobbies: Running and basketball

Latest Book Read: *The Courage to Teach* by Parker Palmer

Latest Publication: (With Caleb Raible-Clark) *The Quest Draft: an Automated Course Allocation Algorithm*, winner of the Deployed Application award, AAAI-2014 conference, Quebec City, July 2014.

Recent News: I have recently finished writing a “math novel”, and have signed a contract with an assisted self-publishing company. In early 2015, Friesen Press will release my novel, *The Math Olympian!*

What I Would Change: I would love to see CMS members build deeper relationships with industry and government, developing math-based solutions to create a more efficient and sustainable world; and to use our skills and talents to serve our places-of-work in ways that go beyond the traditional metric of publications (e.g. one of my most satisfying experiences this year was to mentor several undergraduate students as they designed and implemented a math-based roommate-matching algorithm at my university.)

CMS Roles: CRUX with Mayhem, Mathematical Competitions Committee, Education Committee, organizer of the 2014 Canadian Math Education Forum.



Why I Belong to the CMS: Thanks to the CMS, I had the opportunity to achieve my childhood dream in 1996, representing Canada at the International Mathematical Olympiad. Since then, I have had a desire to give back to the community that changed the direction of my life. Through running CMS math camps, coaching the Canadian IMO team, attending and organizing CMS education fora, speaking at CMS meetings, and serving on various CMS committees, I’ve discovered the impact and influence of this remarkable organization. I am honoured to be an active member of the CMS, and will continue to be an active member in the coming years.



2014 CMS
Winter Meeting
December 5 - 8, 2014 • Hamilton, Ontario



2014 CMS Winter Meeting

December 5 - 8, 2014, Hamilton (Ontario)
Hamilton Sheraton
Host: McMaster University

cms.math.ca/events/winter14

Prizes | Prix

Jeffery-Williams Prize | Prix Jeffery-Williams
Askold Khovanskii (University of Toronto)

Doctoral Prize | Prix de doctorat
Xiangwen Zhang (McGill)

**Graham Wright Award for Distinguished Service
Prix Graham Wright pour service méritoire**
recipient to be announced | lauréat à confirmer

Adrien Pouliot Award | Prix Adrien-Pouliot
recipient to be announced | lauréat à confirmer

**David Borwein Distinguished Career Award
Prix David-Borwein de mathématicien émérite pour
l'ensemble d'une carrière**

Kenneth R. Davidson (University of Waterloo)

G. de B. Robinson Award | Prix G. de B. Robinson
recipient to be announced | lauréat à confirmer

Early Bird Deadline
September 30



Réunion d'hiver 2014 de la SMC

5-8 décembre 2014, Hamilton (Ontario)
Hamilton Sheraton
Hôte : Université McMaster

smc.math.ca/reunions/hiver14

Public Lectures | Conférence publiques

Jeffrey Rosenthal (Toronto)

Plenary Lectures | Conférences plénières

Isaac Goldbring (UIC)

Miroslav Lovric (McMaster)

Laure St. Raymond (École normale supérieure)

Jacques Vanneste (University of Edinburgh)

Scientific Director | Directeur scientifique

Nicholas Kevlahan : kevlahan@mcmaster.ca

Deirdre Haskell : haskell@math.mcmaster.ca

Related Events | Événements liés

CMS Townhall Meeting and NSERC will be present to address any questions from CMS members

The Canadian Mathematical Society invites you to their **awards banquet** on Sunday December 7 to highlight exceptional performance in the area of mathematical research and education at the Hamilton Art Gallery. Prizes will be awarded during the event.

La Société mathématique du Canada vous invite à son **banquet pour souligner** des contributions exceptionnelles en recherche mathématique et en enseignement des mathématiques. Les prix seront remis durant la soirée.



SMC 2014
Réunion d'hiver
5 - 8, décembre 2014 • Hamilton, Ontario



Regular Sessions | Sessions générales

Algebraic Geometry of Moduli Spaces | Géométrie algébrique des espaces de formes modulaires

Ruxandra Moraru (Waterloo), Steven Rayan (Toronto)

Arithmetic Algebraic Geometry Géométrie algébrique arithmétique

Manfred Kolster (McMaster)

Automorphic Forms and Representation Theory Formes automorphiques et théorie des représentations

Chung Pang Mok (McMaster), Moshe Adrian (Toronto)

Computability Theory | Théorie de la calculabilité

Barbara Csima (Waterloo), Peter Cholak (Notre Dame)

Commutative Algebra: Interactions with Algebraic Combinatorics, Algebraic Geometry, and Representation Theory | Algèbre commutative : interactions avec la combinatoire algébrique, la géométrie algébrique et la théorie des représentations

Adam van Tuyl (Lakehead), Tony Geramita (Queens)

Differential Geometry | Géométrie différentielle

Spiro Karigiannis, Benoit Charbonneau (Waterloo), McKenzie Wang (McMaster)

Dynamics of Biological Systems Dynamique des systèmes biologiques

Ben Bolker, Jonathan Dushoff (McMaster)

Dynamical Systems with Applications in Mathematical Biology | Systèmes dynamiques et applications en biologie mathématique

Gail Wolkowicz (McMaster), Hermann Eberl (Guelph)

Financial Mathematics | Mathématiques financières

Traian Pirvu (McMaster)

Frames, Fractals, Tiling, and Wavelets, in Connection with the Fuglede's Conjecture | Cadres, fractales, pavages et ondelettes, par rapport à la conjecture de Fuglede

Chun-Kit Lai, Jean-Pierre Gabardo (McMaster)

Game theory: Recent Advances and Applications Théorie des jeux : dernières percées et applications

Monica Cojocar (Guelph)

Recent advances in variational analysis and linear optimization | Percées récentes en analyse variationnelle et en optimisation linéaire

Antoine Deza (McMaster), Henry Wolkowicz (Waterloo)

Geometric Discretization Methods and Adaptivity Méthodes de discrétisation géométrique et adaptativité

Gantumur Tsogtgerel (McGill), Marc Laforest (polytechnique Montreal)

Geometry and Topology of Manifolds in Low-Dimensions Géométrie et topologie de variétés en basse dimension

Hans Boden (McMaster), Liam Watson (UCLA)

Environmental and Geophysical Fluid Dynamics Dynamique des fluides en géophysique et en science de l'environnement

Francis Poulin (Waterloo)

Model Theory | Théorie des modèles

Patrick Speissegger, Omar Sanchez (McMaster)

Non-linear PDE of mathematical physics | Les EDP nonlinéaires venant de la physique mathématique

Lia Bronsard, Stan Alama (McMaster)

Operator Algebras and Operator Theory Algèbres d'opérateurs et théorie des opérateurs

Ken Davidson (Waterloo), Matthew Kennedy (Carleton)

Origin and Evolution of Bacterial Genomes Origine et évolution des génomes bactériens

Paul Higgs, Ralph Pudritz (McMaster)

Stochastic Models and Applications Modèles stochastiques et applications

Shui Feng (McMaster), Bruno Remillard (HEC Montreal)

Teaching Introduction to Proofs Courses Enseigner l'introduction aux preuves

Shay Fuchs, Jaimal Thind (Toronto)

Toric and Combinatorial Algebraic Geometry Géométrie algébrique torique et combinatoire

Jessie Yang (McMaster), Eric Katz (Waterloo)

Undergraduate Mathematics Education in 21st Century : Rethinking Curriculum | L'enseignement des mathématiques au premier cycle au 21^e siècle : repenser le curriculum

Miroslav Lovric (McMaster), Chantal Buteau (Brock)

Contributed Papers | Communications libres

Jamie Foster (McMaster)

Prize Lectures/Conférences de lauréat

Kenneth R. Davidson (Waterloo)

David Borwein Distinguished Career Award/ Prix David-Borwein de mathématicien émérite pour l'ensemble d'une carrière

AARMS-CMS Student Poster Session

Présentations par affiches pour étudiants

Past and Present in Mathematics: Notes from the CSHPM

Craig Fraser, *University of Toronto*

This is one of a series of columns in which the Canadian Society for History and Philosophy of Mathematics (CSHPM) shares scholarly work and enthusiasms in those areas with the wider mathematical community. The columns are written by members of the CSHPM and are edited by Amy Ackerberg-Hastings and Hardy Grant. Comments are welcome and may be addressed to either of the editors at aackerbe@verizon.net or hardygrant@yahoo.com.

The Kenneth O. May Prize is awarded every four years to a historian or historians in recognition of distinguished contributions to the history of mathematics. The Prize is administered by the International Commission for the History of Mathematics and awarded on the occasion of the International Congress for History of Science, Technology and Medicine, held every four years. The ICHM is a member commission of the International Union for History and Philosophy of Science and Technology and the International Union of Mathematics.

Kenneth Ownsworth May (1915-1977) was an American mathematician and historian of mathematics who spent the last ten years of his career at the University of Toronto. He founded the International Commission for the History of Mathematics, the Canadian Society for History and Philosophy of Mathematics, and the journal *Historia Mathematica*. In addition to his work in the history of mathematics he also made pioneering contributions to the field of computer information retrieval and to mathematics education. May was the author of *Elements of Modern Mathematics* (Reading, Mass.: Addison-Wesley, 1959) and *Bibliography and Research Manual of the History of Mathematics* (Toronto: University of Toronto Press, 1973). He wrote the article on Carl Friedrich Gauss for the *Dictionary of Scientific Biography*.

The first May prize was awarded in 1989; to date there have been 12 winners. The recipient of the Prize also receives the May Medal, a bronze medallion cast from a design created by the Canadian sculptor Salius Jaskus. A full list of past winners and citations for these awards may be found on the website of the ICHM (<http://www.unizar.es/ichm/mayprize.htm>).

The 24th ICHSTM was held in Manchester, UK in July of 2013. The two winners of the May Prize for 2013 are Menso Folkerts and Jens Høyrup. The Prize was presented to them by Craig Fraser, chair of the ICHM.

Menso Folkerts is a German historian of mathematics, born in 1943 and a retired professor at Ludwig-Maximilians-Universität in Munich. He has made extensive contributions to the history of medieval and early modern mathematics, and has also written on other areas of the history of mathematics. Folkerts has played a major role in making primary historical sources available for study to scholars. His leading contribution in this respect is the *Jordanus* catalogue

(<http://archimedes.mpiwg-berlin.mpg.de/iccmsm.html>). Started by Folkerts within the Munich Department for the History of Science, and then since 1997 a joint initiative with the Berlin Max Planck Institute for the History of Science, *Jordanus* is now an open access on-line catalogue listing more than 13,000 mathematical and scientific manuscripts in Latin and Western European vernacular languages produced between the years 500 and 1500 (but also including numerous entries from later centuries). Folkerts's second major contribution to making primary sources available to historians of science is a database of Gauss's correspondence cataloguing more than 7,600 letters—also available as an on-line catalogue.

Folkerts has served as an executive officer of the International Commission for the History of Mathematics, on the Board of Trustees of the Deutsche Museum, and as President of the German Society for the History of Medicine, Science and Technology. He has edited or helped to edit over 12 scholarly journals and book series, including *Boethius* and *Algorismus*. His distinguished service to the community and influential scholarship has been acknowledged with membership in the International Academy for the History of Science (since 1981, corresponding member, and 1986, effective member); the Leopoldina Academy (Deutsche Akademie für Naturforscher, since 1989); the Saxonian Academy of Science (corresponding member since 1998); and the Bavarian Academy of Science (since 1999).

Jens Høyrup is a Danish historian of mathematical science, born in 1943 and a retired professor at Roskilde University. He has worked on several different parts of the history of mathematics but is best known for his contributions to the study of Babylonian mathematics from the period 1800-1500 BC. His major work on this subject is the book *Lengths, Widths, Surfaces: a Portrait of Old Babylonian Algebra and Its Kin* (Springer 2002). From the citation read on the occasion of the awarding of the prize:

Høyrup has pioneered new approaches to the study of Babylonian mathematics which have had an impact beyond the small world of ancient Near Eastern specialists. His method is essentially discourse analysis: taking the technical terminology of Old Babylonian algebra at face value and relating it back to its non-technical meanings in everyday discourse. In this way he has demonstrated incontrovertibly that in the 18th century BC unknowns were conceptualised as having dimension as well as number: algebra was a matter of manipulating lines, areas and volumes in a conceptually very concrete manner. Through close reading of the terminology he has shown that the ancient texts distinguished four different types of multiplication, two different types of addition, and so on.

Høyrup is a member of the International Academy of the History of Science, an associate editor of *Historia Mathematica* and member of the editorial board of *Revue d'Histoire des Mathématiques*. He is a regular reviewer for several journals and publishers in the history of mathematics. He has published approximately thirteen books as author or co-author, about sixty articles in journals, about forty

articles in conference proceedings and other books, and several contributions in encyclopaedic works.

For the full citations that accompanied the awarding of the May Prize to Professors Folkerts and Høyrup see Craig Fraser, "Awarding of the May Prizes for 2013," *Historia Mathematica* 40 (2013): 353–356.

The next Kenneth O. May Medal and Prize will be awarded in 2017 at the 25th International Congress of History of Science, Technology and Medicine in Rio de Janeiro (Brazil).

Biography

Craig Fraser is Director of the Institute for History and Philosophy of Science and Technology of the University of Toronto, where he teaches undergraduate and graduate courses on the history of mathematics and astronomy. From 2009 he has been chair of the International Commission for the History of Mathematics. His research fields are the history of analysis, mathematical mechanics and the foundations of mathematics, with emphasis on the eighteenth and nineteenth centuries.



Advertising in CMS Notes

The Canadian Mathematical Society welcomes organizations and corporations wishing to promote their products and services within the print and digital editions of CMS Notes. All members of the CMS receive a copy of Notes. For rates and sizes check out: <http://cms.math.ca/notes/advertising>

Contact us by

Email: notes-ads@cms.math.ca

Postal: CMS Notes Advertising
Canadian Mathematical Society
209 - 1725 St. Laurent Blvd.
Ottawa ON K1G 3V4
Canada

Tel: (613) 733-2662

Fax: (613) 733-8994

OCTOBER CONTINUED

- 10** PIMS/UBC Distinguished Colloquium: Benedict Gross (*University of British Columbia*)
- 18-19** AMS Regional Meeting (*Halifax, NS*) www.ams.org/amsmtg/sectional.html
- 19-24** Dynamics and C*-Algebras: Amenability and Soficity <http://www.birs.ca/events/2014/5-day-workshops/14w5161>
- 26-31** Biological and Bio-Inspired Information Theory (14w5170) <http://www.birs.ca/events/2014/5-day-workshops/14w5170>
- 27-29** Quantum Optimization Workshop (*Fields Institute*) <http://www.fields.utoronto.ca/programs/scientific/14-15/quantumopt/>
- 29-31** 2014 International Methodology Symposium (*Palais des congrès de Gatineau, Gatineau, QC*) <http://www.statcan.gc.ca/conferences/symposium2014/index-eng.htm>

NOVEMBER 2014

- 1-5** 38th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing (*Wellington, New Zealand*) msor.victoria.ac.nz/Events/38ACCMCC
- 2-7** Geometric Scattering Theory and Applications <http://www.birs.ca/events/2014/5-day-workshops/14w5105>
- 3** The Nathan and Beatrice Keyfitz Lectures in Mathematics and the Social Sciences (*Paul Milgrom (Stanford University)/Fields Institute*) http://www.fields.utoronto.ca/programs/scientific/keyfitz_lectures/
- 6** Canadian Open Mathematics Challenge <http://cms.math.ca/Competitions/COMC/2014/>
- 7-8** Workshop on Statistical Issues in Biomarker and Drug Co-development (*Fields Institute, Toronto*) <http://www.fields.utoronto.ca/programs/scientific/14-15/biomarker/>
- 9-14** Particle-Based Stochastic Reaction-Diffusion Models in Biology (14w5103) <http://www.birs.ca/events/2014/5-day-workshops/14w5103>
- 14** Hugh C. Morris Lecture: Cedric Villani (*University of Lyon & Institut Henri Poincaré*) *University of Victoria*
- 15** Workshop on Kinetic Theory and Related Topics (*University of Victoria*)
- 16-21** Algorithms for Linear Groups (14w5031) <http://www.birs.ca/events/2014/5-day-workshops/14w5031>
- 17-20** Fields Medal Symposium (*Fields Institute, Toronto, ON*) <http://www.fields.utoronto.ca/programs/scientific/fieldsmedalsym/>
- 17-21** Categorical Structures in Harmonic Analysis (*MSRI, CA*) <http://www.msri.org/workshoops/708>
- 23-28** Algebraic and Model Theoretical Methods in Constraint Satisfaction <http://www.birs.ca/events/2014/5-day-workshops/14w5136>
- 24-28** Conference "The Legacy of Vladimir Arnold" (*Fields Institute, Toronto, ON*) <http://www.fields.utoronto.ca/programs/scientific/14-15/arnoldconf/>
- 30-Dec 5** Families of Automorphic Forms and the Trace Formula (HALF) <http://www.birs.ca/events/2014/5-day-workshops/14w5120>

DECEMBER 2014

- 5-8** CMS Winter Meeting (*Hamilton, ON*) <http://www.cms.math.ca/events/summer14>

Call for Nominations PIMS Postdoctoral Fellowship Competition

The Pacific Institute for the Mathematical Sciences (PIMS) invites nominations of outstanding young researchers in the mathematical sciences for Postdoctoral Fellowships for the year 2015-2016. Candidates must be nominated by at least one scientist or by a Department (or Departments) affiliated with PIMS. The fellowships are intended to supplement support provided by the sponsor, and are tenable at any of the PIMS Canadian member universities: the University of Alberta, the University of British Columbia, the University of Calgary, the University of Lethbridge, the University of Regina, the University of Saskatchewan, Simon Fraser University and the University of Victoria, as well as at the PIMS affiliate, the University of Northern British Columbia.

Program Features

Nominees must have a Ph.D. or equivalent (or expect to receive a Ph.D. by December 31, 2015) and must be within three years of their Ph.D. at the time of the nomination (i.e., they must have received their Ph.D. on or after January 1, 2012). The fellowship may be taken up at any time between September 1, 2015 and January 1, 2016. The fellowship is for one year and is renewable, contingent on satisfactory progress, for at most one additional year. The amount of the PIMS award for 2015-16 will be \$20,000 and the sponsor(s) is (are) required to provide additional funds to finance a minimum total stipend of \$40,000. PIMS Postdoctoral Fellows are expected to participate in all PIMS activities related to the fellow's area of expertise and will be encouraged to spend time at more than one site. To ensure that PIMS Postdoctoral Fellows are able to participate fully in Institute activities, they may not teach more than two single-term courses per year.

Application Process

- The PIMS PDF nomination/application process takes place entirely online, utilizing the MathJobs service provided by the American Mathematical Society. Having selected their nominees, sponsors direct them to apply online at mathjobs.org/jobs/PIMS. (Detailed instructions regarding all aspects of the MathJobs application procedure may be found in the online MathJobs user guides.) Please note that **application is by nomination only**; unsolicited applications will not be considered. Please note that all nominees, **including those associated with PIMS Collaborative Research Groups** must apply through MathJobs.
- Nominees should upload a list of publications, a curriculum vitae and a statement of research interests. Special justification statements should be included if the applicant plans to either (i) continue to work with his/her PhD advisor, or (ii) remain at their current institution.
- Nominees should arrange for two reference letters to be uploaded to MathJobs. At least one letter should be preferably from an outside referee who is at arm's length from the candidate and/or his/her PhD advisor.



Pacific Institute *for the*
Mathematical Sciences

- Sponsors must upload both their own reference letter and a separate statement of financial support that identifies the source of matching funds and the level of teaching required by the candidate in as much detail as possible. Vague or incomplete statements may influence the panel's decision. Sponsors will receive instructions as to how to proceed via an email from MathJobs.

Selection Criteria

Rankings of candidates are made by the PIMS PDF Review Panel based on the following criteria:

- The scientific qualifications of the candidate;
- The fit between the research interests of the candidate and those of the sponsor;
- Adequacy of matching funds
- A maximum of teaching of 2 courses per year (no extra consideration will be given for lower teaching loads.)

Deadlines

Complete applications must be uploaded to MathJobs by December 1, 2014. For further information, visit: <http://www.pims.math.ca/scientific/postdoctoral> or contact: assistant.director@pims.math.ca

2015 CMS
MEMBERSHIP
RENEWALS

RENOUVELLEMENTS
2015 À LA SMC



Your membership notices have been e-mailed. Please renew your membership as soon as possible. You may also renew on-line by visiting our website at www.cms.math.ca/forms/member

Les avis de renouvellements ont été envoyés électroniquement. Veuillez s-il-vous-plaît renouveler votre adhésion le plus tôt possible. Vous pouvez aussi renouveler au site Web www.cms.math.ca/forms/member?fr=1



Arthur Mehta, *CUMC President*

On July 2nd, over 200 top math students from across Canada gathered at the nation's capital for the start of CUMC 2014, hosted by Carleton University. What ensued was a four day epic mathfest featuring 120 student lead lectures, six keynote addresses as well as a recruitment fair, a LaTeX workshop, a Women in Math discussion panel, a Zip-lining event, and an Ottawa river boat cruise.

For me the best part of CUMC has always been interacting with other mathies from around the country, making friends and seeing student talks. Needless to say, this year was not a disappointment. We had over 200 students in attendance from 34 different schools and colleges across the country. From Memorial University of Newfoundland to University of

British Columbia and almost everywhere in between, the conference truly represented the nations undergraduate student body. With nearly 120 student talks there was no shortage of interesting topics. These included interesting topics like How to Help a Group Find It's Daddy Ehsaan Hossain University of Waterloo, and Glimpses of Hyperbolic Geometry Dominique Rathel-Fournier Universite de Montreal. In addition to student talks, Studc members Christina Rousu and Nathan Musoke gave a two hour LaTeX workshop.

“the best part of CUMC has always been interacting with other mathies from around the country”

This year's keynotes featured six top Canadian researchers. The topics were Prime Numbers and Zeta Functions Ram Murty, Queen's University, Linegalite isoperimetrique a travers les ages Alexandre Girouard Laval University, The noncommutative World Matthew Kennedy Carleton University, Evolving Curves Surfaces and More Jean-Christophe Nave, McGill University, Big Data: Mathematics, Statistics and Data Science, Shirley Mills, Carleton University, Average Distributions for Elliptic Curves, Chantal David, Concordia University.

This year's CUMC introduced a brand new element to the conference with a recruitment fair. Graduate schools and employers from across the country were invited to attend a two hour recruitment fair and interact with the conference attendees. Nine different universities and employer recruitment teams came out. The feedback for the event was all around positive, from both attendees and recruiters. Hopefully this can become a permanent part of the conference, providing a source of revenue for future organizers while at the same time providing a great benefit for both attendees and recruiters.

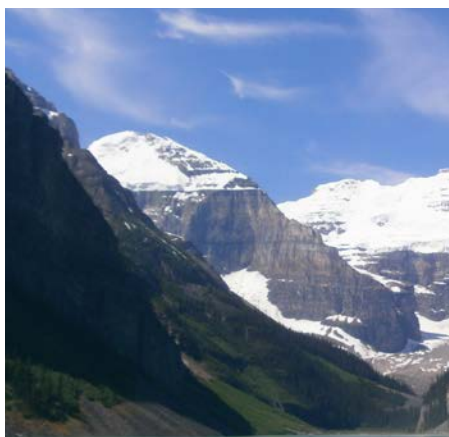
Continuing with the tradition breaking down barriers and promoting an open environment, CUMC 2014 hosted yet another successful Women in Math discussion panel. Open to all genders, over 100 attendees showed up to participate in a discussion group that focused on challenges facing women pursuing careers in mathematics. The discussion was lead by a six member panel featuring three academics Dr Shirley Mills, Dr Anne Broadbent, and Dr Monica Nevins as well as three working professionals, Alexandra Dykes, Ima Okonny, and Angela Wilson.

The fun was not just restricted to math related activities. CUMC 2014 featured an exciting social events. On the Thursday afternoon over 70 attendees braved rain, bugs and the the threat of thunderstorms to go Zip-lining at Camp Fortune in Quebec. Luckily, weather cleared up just as we arrived and the event was a blast.

We decided to end the conference in style by hosting our closing banquet on a three-floor chartered cruise ship. We enjoyed a three hour boat cruise around the Ottawa river and behind the parliament hill. Everyone had a great time and I think the whole experience is modeled well by the following equation.

$$\frac{\text{High end catering} + 2 \text{ bars} + 200 \text{ mathies}}{\text{Ottawa River}} = \text{WIN!}$$

“We enjoyed a three hour boat cruise around the Ottawa river and behind the parliament hill”



David Arthur, IMO Team Leader

Imagine yourself halfway across the world in South Africa. It is winter and you are sitting in a gym with 500 other people. You are not there to play sports or to watch them. Instead, you are pitting yourself against 6 devilish math problems, competing with the very best in the world. Are you excited, nervous, bored, or maybe just cold?

In July, there were six Canadian high school students sitting in that gym, representing us at the 2014 International Math Olympiad. They were excited and yes a little bit cold, but most of all, they were ready.

It ended up being a phenomenal year for Canada at the IMO. The team came in 9th place out of 101 countries, the second best performance Canada has ever had. Alex Song and Kevin Sun won gold medals, Antonio Molina Lovett won a silver medal, and Alexander Whatley, Caleb Ji, and Michael Chow each won bronze medals. Alex Song now has 4 gold medals all by himself, tied for the most ever by a single student. He even has more one more year of eligibility left, which means he has a chance to take the record all for himself!

As always, the problems were approachable but very tough. One of them in particular had an unusual twist this year:

A set of lines in the plane is in “general position” if no two are parallel and no three pass through the same point. A set of lines in general position cuts the plane into regions, some of which have finite area; we call these its finite regions. Prove that for sufficiently large n , in any set of n lines in general position, it is possible to colour at least $\infty * \sqrt{n}$ lines blue so that none of its finite regions has a completely blue boundary.

Note: Results with \sqrt{n} replaced by $c * \sqrt{n}$ will be awarded points depending on the value of the constant c .

At the IMO, students normally have one specific thing to prove and they earn partial credit based on how close they come to proving it. This problem was a little more open-ended. We asked the students to prove the best bound they could, and then gave partial credit only for complete proofs of various bounds.

In fact, the problem is true even when $c = \infty$, and we were ready to give out an elusive IMO “special prize” to anyone who could prove it. Nobody managed that feat during the contest, but nonetheless it was great fun for the coaches to read through our students’ work. On our team, Kevin came up with 4 different solutions by himself, each proving a better bound than the previous one. If he should continue on to do research mathematics, I suspect this creativity and persistence will serve him very well!

Looking back, the summer began with two weeks of training in the beautiful mountains of Banff, including breaks for day-long hikes and cards. The students liked to play Euchre, but in a cruel twist, they made the losing teams do push-ups! It ended in Cape Town with six medals and a host of new memories.

Personally, I am proud to have been a part of it, and I wish the best of luck to all six students in the upcoming year. Four of them will be back in school but it won’t be easy for them to top this year’s success at the IMO!

**If undelivered, please return to:
Si NON-LIVRÉ, prière de retourner à :**

CMS Notes / Notes de la SMC
209 - 1725 St. Laurent Blvd Ottawa, ON K1G 3V4 Canada