



June 29 IMO Math Team Canada Reunion.....5

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CMS
SMC

Canadian Mathematical Society
Société mathématique du Canada

CMS NOTES de la SMC

June / juin
2017

A message from our outgoing president / Message de la Présidente sortante

Lia Bronsard (McMaster)

Past President / Présidente sortante

A true learning experience!



As president-elect, incumbent president and, now, outgoing president, I've observed the CMS's activities first hand, and it's been a tremendous privilege that has taught me a lot.

Firstly, I saw that mathematicians give very generously of their time. That's a big plus, because the CMS relies heavily on volunteers to fulfill its mission. One reason is our 30 committees, all of which play a critical role in our operations. The research committee, for instance, has the daunting task of selecting the winners of the CMS awards among an always excellent crop of candidates. And committees like education, publications and international relations place especially heavy demands on their members.

What's more, the resounding success and outstanding quality of our semi-annual meetings are the handiwork of the many members who organize the scientific and educational sessions, and of the scientific directors and committee members for each meeting. Thanks to the time and dedication of these fellow mathematicians, the world-class caliber of our meetings is a given. All I can say is hats off to one and all.

Because CMS meetings cover broader mathematical topics, they play a much different role than do our centers, specifically that of offering cross-disciplinary networking right across the country. In addition, as CMS is a mathematical association, it can host international conferences like the

J'ai beaucoup appris !

En tant que présidente élue, présidente de la SMC et maintenant présidente sortante, j'ai pu voir de première main toutes les activités de la SMC et ce fût un grand privilège.

D'abord j'ai vu que les mathématiciens sont généreux avec leurs temps. La SMC compte beaucoup sur le bénévolat de ses membres afin d'accomplir sa mission. Nous avons beaucoup de comités, tous fondamentaux pour la SMC, tel que le comité de recherche qui est en charge de déterminer les prochains récipiendaires des prix de la SMC, ce qui n'est pas facile car il faut choisir entre tous ces excellents candidats ! Plusieurs de ces comités demandent un travail assidu, comme le comité de publication, le comité d'éducation, le comité des relations internationales, pour ne nommer que quelques-uns de nos 30 comités, tous essentiels à la mission de la SMC.

Par ailleurs, le grand succès et la grande qualité de nos conférences biennuelles est dû aux nombreux organisateurs des sessions scientifiques et des sessions d'éducation, ainsi qu'aux directeurs scientifique et aux membres du comité scientifique de chaque conférence. Le temps et dévouement de ces mathématiciens est ce qui rend nos conférences de calibre international, et je dis chapeau bas !

Les conférences de la SMC n'étant pas des conférences spécialisées, elles remplissent un rôle bien différent que celles de nos centres : celui du réseautage à travers disciplines et au travers du Canada. De même, la SMC étant une société mathématique, cela lui permet d'être les hôtes de conférences internationales comme le prochain *Congrès Mathématique des Amériques (CMA)* qui se tiendra en juillet 2017 à Montréal. Nous serons aussi les hôtes du *Congrès International Physique-Mathématiques (CIPM)* qui se tiendra à Montréal en 2018. Ces

Continued on page 4

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Talking Mathematics

Robert Dawson, CMS Notes Editor-in-Chief



A few weeks back I was advising a student about analyzing and solving symbolic logic problems. A piece of advice that seemed to help a lot was to read the problem aloud in natural language. Why does this work? Why do well-presented lectures and conference talks clarify things so much? And, conversely, why is the notation-heavy *Principia Mathematica* so notoriously hard to read?

Perhaps the part of the brain that handles language can do a certain amount of symbolic computation on its own, without bothering the conscious mind. There's some evidence for this in the bizarre structures that turn up in natural languages, without giving habitual speakers any trouble whatsoever. An example in English is the double possessive.

Maybe you didn't even realize that English had a double possessive? Fair enough: most school English curricula don't mention it. It's what you use when you say "She's a friend of mine." Now, "mine" is already possessive – so why do we need the "of?" We just do, that's all.

But it gets worse. We don't say "she's the friend of mine." It seems that some articles are allowed, some aren't! "A friend of Bill's" and "a toy of the cat's" are correct, "a wheel of the car's" and "a wheel of its" aren't. Animate versus inanimate? And some double possessives are optional, some not: you can get away with "a friend of Bill" but not with "a friend of me." Finally, it's only valid for genuine possessives: you must say "a book of hers" but "a glimpse of her."

Chances are, if English is your first language, you've never consciously learned these complicated rules and may never have realized that they exist. We make these decisions fairly consistently and completely unconsciously. (If you're reading this in French, once you've stopped laughing at that crazy English language, take a moment to think about grammatical genders, verbs conjugated with être, and those sneaky adjectives that change meaning depending on position.)

The student found that, for instance, de Morgan's laws became more obvious and easier to remember when read aloud as "not A-and-B is the same as not-A or not-B." Other elements of mathematics become easier as illustrations or commutative diagrams. Tricking our brains into doing our work for us is an honorable tradition in mathematics!

Verbaliser les mathématiques

Il y a quelques semaines, je conseillais un étudiant sur l'analyse et la résolution de problèmes logiques symboliques. Un conseil qui a semblé beaucoup l'aider : lire le problème à haute voix de façon naturelle. Comment faire? Pourquoi les conférences et les séances de congrès bien présentées clarifient-elles autant les choses? Et, à l'inverse, pourquoi les *Principia Mathematica*, si denses en notations, sont-ils notoirement difficiles à lire?

Peut-être que la partie du cerveau qui traite le langage pourrait faire elle-même une certaine partie du calcul symbolique sans même avoir besoin de l'esprit conscient? C'est ce que l'on constate en s'attardant aux structures étranges qui apparaissent dans la langue naturelle, structures qui ne donnent pourtant aucun mal aux locuteurs qui parlent couramment la langue. Prenons l'exemple du double possessif en anglais.

Vous ne saviez même pas qu'il existait un double possessif en anglais? C'est fort possible puisque la plupart des programmes d'anglais n'en font pas mention. Un double possessif, c'est le fait de dire *She's a friend of mine*. Le mot *mine* étant déjà un possessif (le mien), pourquoi aurait-on besoin de *of*? Mais nous l'ajoutons naturellement, c'est comme ça.

Mais il y a pire. Personne ne dit *she's the friend of mine*. Il semble donc que certains articles sont autorisés, mais que d'autres ne le sont pas! Par exemple, les phrases *A friend of Bill's* et *a toy of the cat's* sont correctes, mais *a wheel of the car's* et *a wheel of its* ne le sont pas. La différence tient-elle au caractère animé ou inanimé du sujet? De plus, certains doubles possessifs sont facultatifs, et d'autres non : on peut par exemple très bien dire *a friend of Bill*, mais pas *a friend of me*. Enfin, cela ne vaut que pour les possessifs véritables : il faut dire *a book of hers*, mais *a glimpse of her*.

Bref, si l'anglais est votre langue maternelle, vous n'avez probablement jamais consciemment appris ces règles complexes, et n'avez peut-être jamais pris conscience de leur existence. Nous prenons ces décisions de façon assez cohérente et tout à fait inconsciemment. (Si vous lisez ceci en français, une fois que vous aurez cessé de rigoler des bizarreries de la langue anglaise, prenez deux minutes pour penser aux genres grammaticaux, aux verbes conjugués avec être et à ces adjectifs sournois dont le sens change selon qu'ils sont placés avant ou après le nom...)

L'étudiant a constaté que, par exemple, les lois de De Morgan sont devenues plus évidentes et plus faciles à mémoriser s'il les lisait à haute voix, par exemple « non (A et B) est identique à (non A) ou (non B) ». D'autres éléments des mathématiques deviennent plus simples lorsqu'on les illustre ou qu'on les représente par des diagrammes commutatifs. Amener notre cerveau à faire le travail à notre place est une tradition honorable en mathématiques!

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 en anglais portant sur n'importe quel sujet d'intérêt mathématique, mais ils se réservent le droit de les compresser. 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.

2017 CMS MEMBERSHIP RENEWALS RENOUVELLEMENTS 2017 À LA SMC



The 2017 membership renewal has begun! Please renew your membership online as soon as possible at portal.cms.math.ca by logging into your member account. Should you have any questions, please email us at memberships@cms.math.ca

Le renouvellement pour l'an 2017 a commencé! S'il vous plaît renouveler votre adhésion en ligne dès que possible à portail.smc.math.ca et en vous connectant à votre compte de membre. Si vous avez des questions, s'il vous plaît écrivez-nous à adhesions@smc.math.ca

NOTES DE LA SMC

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Rédacteurs en chef

Robert Dawson et Srinivasa Swaminathan
(notes-redacteurs@smc.math.ca)

Rédactrice-gérante

Denise Charron (redacteur-gerant@smc.math.ca)

Adjointe à la rédaction

Melissa Bingöl-Phillips (commmsp@smc.math.ca)

Comité de rédaction

Pédagogique : John McLoughlin et Jennifer Hyndman
(notes-education@smc.math.ca)

Comptes-rendus de livres : Karl Dilcher
(notes-critiques@smc.math.ca)

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

Recherche : Patrick Ingram
(notes-recherche@smc.math.ca)

SCHPM : Amy Ackenberg-Hastings
(aackerbe@verizon.net) et
Hardy Grant (hardygrant@yahoo.com)

Calendrier : Denise Charron
(redacteur-gerant@smc.math.ca)

Les rédacteurs des Notes de la SMC accueillent vos articles, lettres et notes. Indiquer la section choisie pour votre article et le faire parvenir à l'adresse courriel appropriée ci-dessus.

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

CMS NOTES

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Editors-in-Chief

Robert Dawson and Srinivasa Swaminathan
(notes-editors@cms.math.ca)

Managing Editor

Denise Charron (managing-editor@cms.math.ca)

Editorial Assistant

Melissa Bingöl-Phillips (commmsp@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: Patrick Ingram
(notes-research@cms.math.ca)

CSHPM: Amy Ackenberg-Hastings
(aackerbe@verizon.net) and
Hardy Grant (hardygrant@yahoo.com)

Calendar: Denise Charron
(managing-editor@cms.math.ca)

The editors welcome articles, letters and announcements. Indicate the section chosen for your article, and send it to CMS Notes at the appropriate email address indicated above.

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COMITÉ EXÉCUTIF

Président : Michael Bennett (UBC)
president@smc.math.ca

Présidente sortant : Lia Bronsard (McMaster)
pres-sortant@smc.math.ca

Vice-président Atlantique :
David Pike (Memorial)
vp-atl@smc.math.ca

Vice-présidente Québec :
Chantal David (Concordia)
vp-que@smc.math.ca

Vice-président Ontario :
Rahim Moosa (Waterloo)
vp-ont@smc.math.ca

Vice-président Ouest :
Raj Srinivasan (Saskatchewan)
vp-ouest@smc.math.ca

Vice-président Pacifique :
Florin Diacu (Victoria)
vp-pac@smc.math.ca

Trésorier : David Oakden
tresorier@smc.math.ca

Secrétaire général : Graham P. Wright
secgen@smc.math.ca

La Société mathématique du Canada appuie l'avancement, la découverte, l'apprentissage et l'application des mathématiques. L'exécutif de la SMC encourage les questions, commentaires et suggestions des membres de la SMC et de la communauté.

EXECUTIVE COMMITTEE

President: Michael Bennett (UBC)
president@cms.math.ca

Past President: Lia Bronsard (McMaster)
past-pres@cms.math.ca

Vice-President – Atlantic:
David Pike (Memorial)
vp-atl@cms.math.ca

Vice-President – Quebec:
Chantal David (Concordia)
vp-que@cms.math.ca

Vice-President – Ontario:
Rahim Moosa (Waterloo)
vp-ont@cms.math.ca

Vice-President – West:
Raj Srinivasan (Saskatchewan)
vp-west@cms.math.ca

Vice-President – Pacific:
Florin Diacu (Victoria)
vp-pac@cms.math.ca

Treasurer: David Oakden
treasurer@cms.math.ca

Corporate Secretary: Graham P. Wright
corpsec@cms.math.ca

The CMS promotes the advancement, discovery, learning and application of mathematics. The CMS Executive welcomes queries, comments and suggestions from CMS members and the community.

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

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Continued from cover

Mathematical Congress of the Americas (MCA) slated for July 2017 in Montreal. We'll also be home to the *International Congress in Mathematical Physics (ICMP)* in 2018, again in Montreal. These initiatives, along with the prizes awarded to Canadian mathematicians every year, underscore the CMS's contributions on both the national and international stages.

I have also seen how much the concept of sponsorship has changed and how we need to adapt to this evolving landscape. In a nutshell, not only do corporations no longer "give" to education, but their much-appreciated financial support for our competitions—dating back more than 40 years in some cases—is coming to an end. We therefore have to find other ways of financing our activities.

The CMS did launch a fundraising campaign, but, truth be told, we still have to get used to such "new ways" of doing things. If we are to pursue our mission successfully, especially in the area of education, we need to tackle our funding challenges. We've long relied on our quality journals, but it's now time to try another model. Through all of this, the discussions on whether to hold one or two meetings a year continue; that said, these activities pay for themselves, so the real issue lies with the funding of our educational initiatives.

For instance, the CMS has full responsibility for the team that represents Canada at the International Mathematical Olympiad, a huge financial commitment that urgently begs for sponsorships. We also promote mathematics among Canada's youth by helping to finance math camps across the country and by sponsoring a nationwide high-school competition for roughly 6,500 students. In addition, the CMS shines the spotlight on budding mathematicians during its semi-annual meetings, now hosting not only a poster

competition, but also a scientific session where graduate and undergraduate students can present the results of their research. These efforts will nurture the next generation of mathematicians and, more generally, the ranks of individuals well versed in science. Keeping the funds flowing here is essential.

I learned as well that, as mathematicians, we must continue to support each other and to see our colleagues as a united, cohesive group that has to take the interests of mathematics to heart—no matter what they are—so that our discipline remains well represented in the scientific world. That said, I've noticed that the CMS is putting more and more effort into showcasing all mathematics circles at its meetings. The question now is whether NSERC can send more resources our way so that we can in turn help mathematics gain ground in Canada's universities.

Operationally, the CMS has undergone major restructuring over the past few years. We have also modernized our computer systems and continue to do so. Staff-wise, we need a new executive secretary to replace Graham Wright in 2017.

Finally, and most of all, I realized how important it is to be surrounded by a supportive team. My heartfelt thanks go out to everyone at the CMS for their outstanding work and unwavering dedication. Their contributions to CMS meetings are especially remarkable. Of course, I also thank the members of the Executive Committee and our new president, Mike Bennett, whose term I hope will bring much pleasure and satisfaction.

As I move on, my hope is that the mathematics community will continue to fuel the future of the CMS as both a scientifically vibrant and financially stable organization.

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Suite de la couverture

faits, et les prix remis aux mathématiciens canadiens chaque année, montrent que la SMC a un rôle important à jouer, tant sur la scène national qu'international.

J'ai aussi appris que le monde de la commandite a beaucoup changé et que nous devons nous adapter à ce changement « culturel ». En effet, les grandes industries ne « donne » plus pour l'« éducation » et leur financement, très apprécié pour nos compétitions, qui ont parfois duré plus de 40 ans, touche à leur fin. Il nous faudra donc trouver d'autres façon de financer nos activités.

La SMC a commencé une campagne de financement, mais nous ne sommes pas habitués à ces « nouvelles idées ». Pour que la SMC puisse continuer sa mission, en particulier sa mission en éducation, il nous faudra se pencher sur les problèmes de financement. Nous avons longtemps compté sur nos journaux de qualité, mais il nous faudra un nouveau modèle. Le débat entre avoir une ou deux conférences par année continue, mais ces conférences s'auto-financent. C'est le financement de nos activités en éducation qui est problématique. Par exemple, c'est la SMC qui est entièrement en charge de l'équipe représentant le Canada aux *Olympiades internationales de mathématiques* du monde. Or ceci représente un coût énorme pour la SMC, et nous avons un besoin urgent de commanditaires pour cet événement. Nous aidons aussi à promouvoir les mathématiques auprès des jeunes canadiens en aidant au financement des camps mathématiques à travers le pays, et en finançant une compétition nationale au niveau secondaire d'environ 6500 élèves. De plus la SMC promeut les jeunes lors de ses conférences biannuelles et nous avons maintenant non seulement une compétition d'affiches mais aussi une session scientifique pour que les jeunes au niveau sous-gradué et au niveau gradué puissent présenter leurs résultats de recherche. Ce sont ces démarches qui vont nous donner une nouvelle génération de mathématiciens et plus généralement de gens bien éduqués en science, et elles ont besoin de financement.

J'ai aussi appris que les mathématiciens doivent continuer de s'entraider et se voir comme un groupe cohésif qui doit prendre l'intérêt des mathématiques à cœur (quels qu'ils soient) afin d'être bien représenté dans le monde des sciences. Je note que la SMC fait de plus en plus d'effort pour représenter tous les groupes de mathématiques lors de ses conférences biannuelles. Il reste à voir si le CRSNG pourra nous allouer plus de ressources afin que nous puissions faire épanouir les mathématiques dans les universités canadienne.

Enfin, la SMC s'est beaucoup restructurée lors des quelques dernières années. Nous cherchons présentement un nouveau secrétaire exécutif qui remplacera Graham Wright en 2017. Nous avons aussi modernisé notre système informatique et y travaillons encore.

Finalement, j'ai appris aussi que c'est important d'être bien secondée et j'aimerai tout particulièrement remercier l'équipe de la SMC pour leur travail phénoménal, constant et sans répit : leur apport lors des conférences de la SMC est tout particulièrement de premier ordre. Bien sûr, je remercie tous les membres du comité exécutif, notre président Mike Bennett et je souhaite bien du plaisir à notre future président.

Je termine en espérant que la communauté mathématique continuera à contribuer à l'avenir d'une SMC en pleine santé scientifique et financière !

June 29 IMO Math Team Canada Reunion

A reunion of former **IMO Math Team Canada** teammates will be held on Thursday, June 29, concurrent with the Sendoff Reception for *Math Team Canada* when they leave to compete in the 58th *International Mathematical Olympiad* in Rio de Janeiro, Brazil.

An **IMO Sendoff Reception** is scheduled for 11:30 am – 12:30 pm and a luncheon is scheduled from 12:30 pm – 2 pm.

The reception will be followed by a **informal focus group discussion** (2:00 pm – 4:00 pm) about what can be done to raise public consciousness about the importance of mathematics to Canada's future.

Finally, we have a **7:00 pm informal dinner reservation at Bar Mercurio**, located at 270 Bloor Street West, Toronto, M5S 1V8.

There is a block of rooms reserved **Holiday Inn at Bloor and Yorkville**. The rate is \$175 which is the least expensive available. You can book a room by calling 1-877-859-5897 – use the booking code **IMO**.

For more information, please contact David Rodgers at drodgers@cms.math.ca.



The Calendar brings current and upcoming domestic and select international mathematical sciences and education events to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Denise Charron, Canadian Mathematical Society,
(managing-editor@cms.math.ca)

Le calendrier annonce aux lecteurs de la SMC les activités en cours et à venir, sur la scène pancanadienne et internationale, dans les domaines des mathématiques et de l'enseignement des mathématiques. Vos commentaires, suggestions et propositions sont le bienvenue.

Denise Charron, Société mathématique du Canada
(redacteur-gerant@smc.math.ca)



JUNE 2017 JUIN

- May 27-2** CSHPM 2017 Annual Meeting, Ryerson University, Toronto, Ont.
- May 28-2** BIRS Workshop: **Arithmetic Aspects of Explicit Moduli Problems**, BIRS, Banff, Alta.
- May 29-9** CRM School and Workshop: **Algebraic and Geometric Combinatorics of Reflection Groups**, CRM, Montreal, Que.
- 2-5** 2017 Prairie Discrete Math Workshop, Living Skies Conference Centre, Lumsden, Sask.
- 2-6** CMESG (Canadian mathematics Education Study Group) Conference, McGill University, Montreal, Que.
- 4-9** BIRS Workshop: **Mathematical Analysis of Biological Interaction Networks**, BIRS, Banff, Alta.
- 5-30** PIMS-CRM Summer School in Probability, University of British Columbia, Vancouver, B.C.
- 11-16** BIRS Workshop: **Connections in Geometric Numerical Integration and Structure-Preserving Discretization**, BIRS, Banff, Alta.
- 12-15** CanaDAM 2017, Ryerson University, Toronto, Ont.
- 12-23** CRM School and Workshop: **Equivariant Combinatorics**, CRM, Montreal, Que.
- 18-23** BIRS Workshop: **Nilpotent Fundamental Groups**, BIRS, Banff, Alta.
- 25-30** BIRS Workshop: **Mathematical Approaches to Interfacial Dynamics in Complex Fluids**, BIRS, Banff, Alta.

JULY 2017 JUILLET

- 2-7** BIRS Workshop: **Diophantine Approximation and Algebraic Curves**, BIRS, Banff, Alta.
- 7-9** BIRS: **Special Western Canada Linear Algebra meeting**, BIRS, Banff, Alta.
- 10-21** SMS 2017 Summer School: **Contemporary Dynamical Systems**, CRM, Montreal, Que.
- 12-23** International Mathematical Olympiad, Rio de Janeiro, Brazil
- 16-21** BIRS Workshop: **Women in Control: New Trends in Infinite Dimensions**, BIRS, Banff, Alta.
- 16-22** CT 2017: **International Category Theory Conference**, University of British Columbia, Vancouver, B.C.
- 17-21** CAIMS Annual Meeting 2017, Dalhousie University, Halifax, NS
- 19-23** Canadian Undergraduate Mathematics Conference 2017, Université de Montréal, Montreal, Que.
- 20-21** 12th East Coast Combinatorics Conference, University of New Brunswick-Saint John Campus, Saint John, NB

23-28

BIRS Workshop: **Mean Dimension and Sofic Entropy Meet Dynamical Systems, Geometric Analysis and Information Theory**, BIRS, Banff, Alta.

Mathematical Congress of the Americas and CMS Summer Meeting, Centre Mont-Royal and McGill University, Montreal, Que. **Registration is now Open!**

24-28

Congrès mathématique des Amériques et Réunion d'été de la SMC, Centre Mont-Royal et Université McGill, Montréal, Qué. **La période d'inscription est ouverte!**

26-29

MAA **MathFest 2017**, Chicago, Illinois, USA

AUGUST 2017 AOÛT

- Jul 30-4** BIRS Workshop: **Topological Data Analysis: Developing Abstract Foundations**, BIRS, Banff, Alta.
- Jul 30-4** PIMS Workshop: **Current Trends in Dynamical Systems and the Mathematical Legacy of Rufus Bowen**, University of British Columbia, Vancouver, B.C.
- 5** International Collaborative Meeting On Dynamical Systems, University of British Columbia, Vancouver, B.C.
- 6-11** BIRS Workshop: **Latest Advances in the Theory and Applications of Design and Analysis of Experiments**, BIRS, Banff, Alta.
- 7-11** CRM Workshop: **Eighth Montreal Industrial Problem Solving Workshop**, CRM, Montreal, Que.
- 8-10** Coxeter Lecture Series: **Percy Deift**, Field's Institute, Toronto, Ont.
- 13-18** BIRS Workshop: **WIN4: Women in Numbers 4**, BIRS, Banff, Alta.
- 14-18** PRIMA Congress, Oaxaca, Mexico
- 20-25** BIRS Workshop: **Geometric and Structural Graph Theory**, BIRS, Banff, Alta.
- 21-25** Gauge theories, Monopoles, Moduli Spaces and Integrable Systems. A Conference honouring Jacques Hurtubise on his 60th birthday, CRM, Montreal, Que.
- 21-25** PIMS CRG Session: **Lie Theory, Cohomology, and Geometry in Wildrose Country**, University of Alberta, Edmonton, Alta.
- 21-25** Conference on Dynamics in Number Theory and Geometry, Queen's University, Kingston, Ont.
- 27-Sep 1** BIRS Workshop: **The Analysis of Gauge-Theoretic Moduli Spaces**, BIRS, Banff, Alta.
- 28-Sep 1** PIMS Combinatorics of Group Actions and its Applications Workshop, St. John's, N.L.

Seeking an Executive Secretary for the CMS

The Canadian Mathematical Society is currently seeking an individual with enthusiasm, initiative, and a strong interest in supporting the development of the Canadian Mathematical community, to be its next Executive Secretary.

The CMS works hard to promote the discovery, learning and application of mathematics in Canada. The CMS enhances the practice of mathematics in Canada through national conferences and publishing research journals, books, and newsletters in both print and electronic formats. The CMS, with the assistance of volunteers, supports efforts that identify and develop young mathematicians through its math competitions, math camps and other educational activities. The work of the CMS is carried out by a large number of dedicated and enthusiastic volunteers, together with a small experienced staff of eight at the CMS Executive Office in Ottawa.

The role of the Executive Secretary is to support the CMS President (together with the CMS Executive Committee and the chairs of CMS Standing committees) and liaise between them and the staff of the CMS Executive office. This is envisioned as a half-time position. The Executive Secretary is not required to be based in Ottawa, since a portion of this position could be managed remotely. But if the Executive Secretary is not based in Ottawa, they must be able to travel easily to Ottawa, as the expectation is that they will spend at least one day per week at the CMS Executive Office.

For those who know the history of the CMS, there used to be a full-time position (titled Executive Director) that had a different function, namely to administer the Executive Office. Restructuring at the CMS means that staff at the CMS Executive Office now independently manage most of the operations of the CMS. The Executive Secretary position is envisioned instead as providing a single contact, to help operationalize policy decisions of the CMS President and Executive committee via the Executive Office.

The new Executive Secretary will be someone with both administrative experience and broad knowledge of the Canadian Mathematical community. A doctoral degree in Mathematics is required, as well as excellent organizational, interpersonal, and problem solving skills. Detailed requirements for the position are listed in the [on-line job description](#).

The position is ideal for someone who is looking to transition from a full-time academic position to a half-time role. Alternatively, the CMS is also willing to explore the possibility of a half-time secondment (or buyout) from a full-time academic position.

This position offers is a unique opportunity to support the Canadian Mathematical Society, and to enhance the Canadian Mathematical community. It is a varied and flexible position requiring both vision and administrative talent.

Applications, including a covering letter, curriculum vitae and references, are sought by **June 23, 2017** as consideration of applications will begin thereafter.

Applications should be sent to: es-search@cms.math.ca



Book Reviews brings interesting mathematical sciences and education publications drawn from across the entire spectrum of mathematics to the attention of the CMS readership. Comments, suggestions, and submissions are welcome.

Karl Dilcher, *Dalhousie University* (notes-reviews@cms.math.ca)

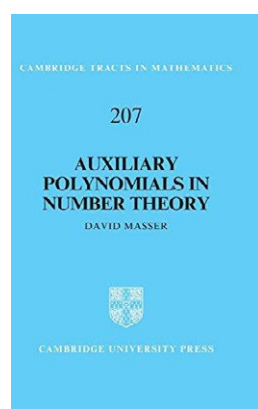
Auxiliary polynomials in number theory

By David Masser

Cambridge University Press, 2016

ISBN: 978-1107061576

Reviewed by *Yann Bugeaud*, *Université de Strasbourg*



The present book gives a detailed and comprehensive account of the method of auxiliary polynomials in many of its forms. Those polynomials, which cannot usually be written down explicitly and whose existence often follows from a suitable version of the Dirichlet Box Principle, play a prominent role in a great variety of proofs in number theory.

Each of the twenty-two chapters (and the appendix) presents an application

of the method, often the simplest in its area, followed by a brief account of subsequent developments and a few dozen exercises (709 in total), whose levels of difficulty range from easy (not many) to (hopelessly) difficult. Topics treated include classical Diophantine approximation (with eight chapters devoted to irrationality, transcendence and algebraic independence), the theory of heights, and elliptic and modular functions. There are also chapters devoted to Runge's method (Runge may well be the inventor of the method of auxiliary polynomials) for the resolution of Diophantine equations, the (strong) Hilbert Irreducibility Theorem, Stepanov's method for counting points on elliptic curves over a finite field, the growth of integer-valued entire functions (with theorems of Pólya and of Gramain), Bilu's equidistribution theorem, and the method developed by Bombieri and Pila for counting rational points on analytic curves.

Let me highlight four classical and important results fully proved in this book: Thue's theorem on approximation to algebraic numbers by rational numbers, a weak form of Dobrowolski's lower bound for the height of a nonzero algebraic number which is not a root of unity, the assertion that the height of any algebraic number satisfying $\alpha^n + (1 - \alpha)^n = 1$ for some integer $n \geq 2$ is at most equal to 10^{120} , and the so-called Théorème Stéphanais on the transcendence of $J(q)$, where J is the modular function and q is a nonzero algebraic number in the open unit disc.

In most (if not all) of the chapters, there is some new material. The author revisits the topic and highlights several issues which were

Les comptes-rendus de livres présentent aux lecteurs de la SMC des ouvrages intéressants sur les mathématiques et l'enseignement des mathématiques dans un large éventail de domaines et sous-domaines. Vos commentaires, suggestions et propositions sont le bienvenue.

Karl Dilcher, *Dalhousie University* (notes-critiques@smc.math.ca)

often neglected. He provides complete, detailed proofs of all the results (unless explicitly stated) and auxiliary statements. He also presents a great variety of concrete examples, sometimes involving (very) large integers (much larger than the ubiquitous 1948) and dares to write down a 13×13 determinant to illustrate the notion of resultant of two polynomials.

The first thirteen chapters are elementary (which, in number theory, is not synonymous with easy) and could be understood by third-year students. Chapters 14 to 22 and the Appendix, although more advanced, should remain accessible to graduate students. Any student or mathematician, including experts in the areas discussed in this book, will gain a lot from reading this book and will also enjoy the style of writing, the many jokes and the author's sense of humour.

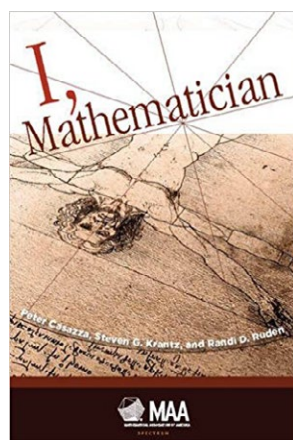
I, Mathematician

Edited by Peter Casazza, Steven G. Krantz, and Randi D. Ruden

MAA, 2015

ISBN: 978-0-88385-585-0

Reviewed by *Chelluri C.A. Sastri*, *Dalhousie University*



What is mathematics? What makes an individual a mathematician? How does the rest of the world view mathematicians and their work? Despite the inherent difficulty in answering these questions, an attempt must be made for at least two reasons. Most branches of science are being studied mathematically these days, the way physics was in earlier times, and new ideas and new ways of thinking are cropping up all the time; it is

essential to sift the grain from the chaff, mathematically speaking, for it could potentially lead to breakthroughs. Another reason is that public understanding and appreciation, and the concomitant support, are vital for the survival and growth of mathematics.

The difficulty alluded to above naturally leads to the existence of a wide variety of opinions, as expressed, for example, by the twenty-four mathematicians and the wife of one of them, a well-known group theorist, who contribute articles to the book under review. Almost all of them have something interesting to say, but some stand out. Before discussing the individual contributions, let's first

look at the way the book is structured. There are plenary articles and secondary ones, with the former being subdivided into two groups, the first dealing with the question “Who Are Mathematicians?” although many of them stray far beyond that, while the second goes under the rubric “On Becoming a Mathematician.” Secondary articles answer the question “Why I Became a Mathematician.” There is a plenary article by Alan Schoenfeld although his name doesn’t appear in the list of plenary contributors mentioned in the Preface, whereas Tom Apostol, James Milgram, and Robert Strichartz are mentioned as plenary contributors, even though there are no articles by them. More striking, however, is the absence, not only of dyed-in-the-wool applied mathematicians such as Joe Keller, but even of stalwarts like Peter Lax, who are known for their work in both pure and applied mathematics. Equally surprising is the absence of probabilists and mathematical statisticians. True, V.S. Varadarajan was a distinguished probabilist at the beginning of his career, but he later switched to representation theory. (Readers might like to know that no less a person than David Mumford said, in a lecture in 2000, one of the millennial ones, that we are now in “The Age of Stochasticity” and that perhaps the axioms of geometry should be stochasticized. By the way, he himself switched to mathematical problems of computer vision and left Harvard for Brown.) Finally, of the twenty-four mathematicians, four are women, two of whom contribute plenary articles.

Not all the essays in the book answer the questions mentioned at the beginning, or at least not the way one would expect. Some of them deal almost exclusively with teaching and math education; some are substantially autobiographical, and at least one, that by Manin, deals only with mathematics per se and its connection to art. Although there are all these differences, there is one invariant without question: the love of mathematics. Indeed, it permeates the whole book.

Since the number of contributors is large, we’ll dispense with quotation marks when discussing a contribution; instead, we’ll specify the contributor’s name and unless otherwise stated, what follows will be either a summary of the author’s contribution or a verbatim reproduction of it. The reviewer’s comments will be either explicitly identified as such or enclosed in parentheses.

The piece by Atiyah is perhaps the shortest but packed with substance, so let’s start with that. He remarks that mathematicians are thinkers and, in theory, could work on a desert island or even in a prisoner-of-war camp. (There are known examples of the latter.) This self-sufficiency causes the general public to view mathematicians with awe and incomprehension. (It becomes even more striking in the case of handicapped mathematicians – witness Pontryagin (blind) and Hawking (ALS).) Isolation and introversion can foster the creative imagination, but when pushed to extremes, can lead to mental illness. Mathematics shares the freedom of creative thought with art but is close to natural sciences and gets anchored to the physical world. Mathematics, because it is part of science, is hierarchical in the sense that all discoveries in it build on earlier work and aim at a unification of knowledge. Thus, for

example, Hilbert could recognize advances made in the twenty-first century, but it is not clear if Bach would appreciate modern music. Science is collaborative, while art in general is not: mathematicians interested in the same topic or problems may collaborate, but it is hard to imagine two or more people composing a poem or a symphony. Although mathematicians can differ from one another in the same way as people in general do, what unites them is a common passion for mathematics and the use of rational methods, with understanding as the final goal.

Two things stand out in Hyman Bass’s essay: one is the nature and importance of proofs – how a proof doesn’t just establish truth but explains it. He says that proof analysis may reveal hypotheses weakly or not at all used and that a thorough analysis of a proof might lead to stronger conclusions than stated in the theorem, or the dropping of some hypotheses. The other is that in teaching elementary and secondary school students, it is better to ask questions rather than provide answers, thereby inviting the students to think on their own and also interact with other students and not just with the teacher. He illustrates this with a diagram, “Instructional Triangle,” where one vertex represents teachers, another content, and the third students interacting with other students. Finally, he gives a beautiful example in which third grade students discuss and come up with a way of proving that the sum of two odd numbers is even.

Sol Garfunkel started out as a logician and taught at Cornell for three years. He was interested in both research and teaching, but following the advice of the Chair there as well as that of John Gardner, then Secretary of Health, Education, and Welfare, he did both for eleven years at UCONN, all the while leaning more and more toward teaching. He got excited by an education project at MIT, where techniques of teaching calculus using a variety of experiments that students could do at home were being developed. He got hooked and became a math educator. He describes in some detail the differences between mathematicians and math educators. He came to believe it’s a positively good thing to teach how mathematics is used. Along with some colleagues he founded COMAP (Consortium for Mathematics and Its Applications), which produces material – modules, books, TV series – that help explain applications of mathematics including newer ones as they come along. It also conducts two annual contests: MCM (The Mathematical contest in Modeling) and ICM (The Inter-Disciplinary Contest in Modeling). All in all, Garfunkel and his colleagues have been performing yeomen’s service in the cause of supporting and strengthening an integrated view of mathematics and of narrowing the chasm between pure and applied mathematics. To the extent that he began as a pure mathematician and ended up as an applied one, he resembles Mumford.

Almost all the contributors bring something of value to the discussion, but unfortunately, because of space limitations, we can’t discuss the rest of the essays here. The full review is available at <https://www.dal.ca/content/dam/dalhousie/pdf/faculty/science/math-stats/Sastri-Bookreview.pdf>.

Education Notes brings 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. Comments, suggestions, and submissions are welcome.

Jennifer Hyndman, University of Northern British Columbia
(hyndman@unbc.ca)

John McLoughlin, University of New Brunswick
(johnngm@unb.ca)

Notes pédagogiques présentent des sujets mathématiques et des articles sur l'éducation aux lecteurs de la SMC dans un format qui favorise les discussions sur différents thèmes, dont la recherche, les activités et les nouvelles d'intérêt. Vos commentaires, suggestions et propositions sont le bienvenue.

Jennifer Hyndman, University of Northern British Columbia
(hyndman@unbc.ca)

John McLoughlin, University of New Brunswick
(johnngm@unb.ca)

Crux Mathematicorum (Crux) is a problem-solving journal published by the CMS. The journal offers a rich collection of problems ranging from those suitable for secondary school students to others not intended for such wide audiences. This issue of Education Notes brings attention to the journal in terms of both its direction and reach. The Missouri State University Problem Solving Group is a regular contributor to Crux, a journal that depends upon input from its readership. A request for some insight into this group was graciously received and the offering is shared here. The opening piece on an established group is followed by a second relating a recent initiative from Ireland, the results of which include contributions to Crux from Foireann Foirfe. Finally, Kseniya Garaschuk puts out a call for support and engagement within a context of moving forward as the Editor of Crux.

Missouri State University Problem Solving Group

Zachary Riel, student writer

Friendships can form in the most unlikely places. For members of the Missouri State University Problem Solving Group, that place happens to be the Schwartz Mathematics Library in Cheek Hall. For the past nine years, the problem-solving group has worked together to solve problems from a variety of mathematical journals. Some members are professors and others are current students, but they all greet each other as friends.

Dr. Les Reid, professor of mathematics at Missouri State, says the group exists to expand students' exposure beyond the traditional problems that they regularly encounter in textbooks and the classroom. "We want them to realize that there actually is a creativity to math," said Reid. "Sometimes students feel like they should know how to proceed with a problem at the very beginning, but we want them to realize that's not always the case."

Kelsie Stewart, a senior majoring in applied mathematics, says the relationships students are able to cultivate with faculty are her favorite part of participating in the group. "Interacting with faculty outside of the normal classroom setting is really cool," said Stewart. "You get to learn more about their personalities and it actually makes it easier to go to them for help – you have more of a personal relationship with them, so it's less intimidating."

Chris Arnold, a mathematics graduate student, says that the encouragement he receives from the faculty is the main reason why he still participates in the group today. "The first time I ever went, I talked to Dr. Richard Belshoff and I told him that I just

didn't feel very effective when it came to the problems they were trying to solve," said Arnold. "I followed along, but most of it was above my head." Belshoff, professor of mathematics at Missouri State, assured Arnold that the problems they deal with can even stump faculty, too, so he shouldn't be discouraged. This support encouraged Arnold to keep coming back. "The faculty treated me like I was important. Even though I didn't fully understand the level of math they were working at, they were willing to help explain it to try to trigger new ideas in my head," said Arnold. "Faculty are people just like you and me — we're in the same boat, and we can all figure it out if we just put our heads together."



Through working together and playing to each member's strengths, the problem-solving group has submitted over 100 solutions, a number of which have been published. Solving these problems with her fellow students and supportive faculty members, says Stewart, reignites her passion for math. "Sometimes when you're just going through everyday school trying to get your degree, you feel like you're doing a lot of things just because you need to in order to graduate," said Stewart. "But this group helps you tackle problems that are super interesting. It piques your interest in math, and then

you're right there again, just wanting to learn. Instead of 'I have to do this,' you want to do it."

(Editor's note: The Missouri State University Problem Solving Group contributed eight solutions to Crux Mathematicorum in 2016, three of which were featured as the published solutions to problems in Contest Corner or Olympiad Corner. Those interested in seeing some of these and other published solutions may wish to visit the link <http://people.missouristate.edu/lesreid/psg/>)

Acknowledgment: Thanks to Nicki Donelson and Shay Stowell of University Communications at Missouri State University for contributing to this submission. The three photos here are credited to Kevin White, Missouri State's Photographic Services.

A Problem-Solving Initiative at NUI Galway

Aisling McCluskey, *National University of Ireland Galway* (aisling.mccluskey@nuigalway.ie)

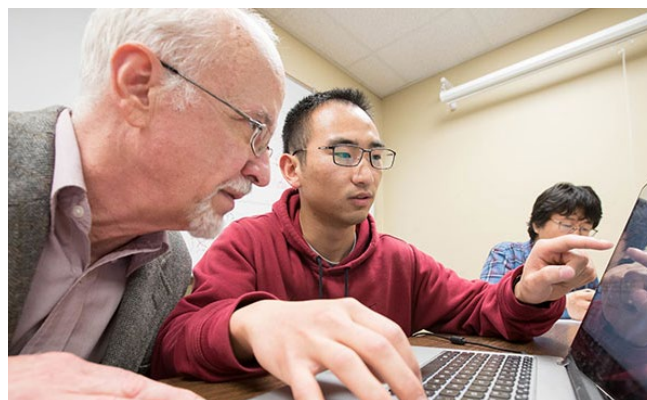
In September 2016, a first year undergraduate mathematics cohort at the National University of Ireland, Galway undertook a semester-long problem-solving initiative led by the collaborative efforts of Prof. John Grant McLoughlin (University of New Brunswick) and Dr. Aisling McCluskey (NUI Galway). The cohort are enrolled in the university's 4-year professional BA in Mathematics and Education degree programme, a programme whose vision is to produce inspirational post-primary teachers of mathematics on the basis of an undergraduate experience that emphasises depth of learning, breadth of knowledge, technological expertise, critical thinking and problem solving skills.

Thus the weekly problem-solving initiative was a natural and invaluable enterprise during the cohort's first semester of university mathematics education. Of the 14 students in the cohort, all but one were school-leavers and so were fresh from the memory and effects of Ireland's post-primary mathematics education system. The students met for one hour each week and were regularly tasked, in small groups, with a Contest Corner quiz. The students were encouraged to continue working on the problems outside of the scheduled formal hour, and to my delight, a number of them did just that. Rather than relegate these mathematical problems as, at best, homework, and at worst, to require no further thought as, in particular, no actual academic credit applied to this initiative, a number of the students worked on them independently and sent their work to me via email. Invariably, their solutions were correct, and the only input from me as facilitator was in how to improve their mathematical writing. This type of problem-solving, not drawn from a particular syllabus as had been their recent experience was brave new territory for them – and they embraced it, and benefited greatly from it. The idea of presenting to each other and subsequently submitting their (and especially individuals') work as a team, Foireann Foirfe, to Contest Corner was further evidence of their team-building capacity for the benefit of all involved. When asked how they found the experience, and in particular what

motivated them to work on the problems as they did, I was told that they enjoyed the freedom of doing the mathematics without being assessed. One student, who contributed significantly to the team effort, commented on how he had willingly spent 2 to 3 hours working on a problem whose solution he then distilled down to one page of polished presentation – just because 'he couldn't leave it alone'! The opportunity to praise genuine effort such as this is invaluable and the experience is likely to have impacted on the students in a significantly positive and enduring way. This was truly mathematics learning and thinking in action, for the good of all.

A subsequent and enterprising development from this initiative has been the piloting of a hugely successful Junior Mathematics Enrichment programme in Semester 2, which saw these students become tutors in a series of seven weekly problem-solving sessions with 40 pupils (aged 13-15 years) selected by their teachers from seven local post-primary schools.

A key aspiration of the BA in Mathematics and Education programme is our students will emerge as future leaders in a turbulent and challenging time of reform and innovation in mathematics education. I am confident that experiences such as described above give them a platform to become such.



Crux Mathematicorum Reaching Out in Transition

Kseniya Garaschuk, *University of the Fraser Valley*

As mathematicians, we notice the changes brought into our lives by computers and the Internet. Getting access to needed resources used to be non-trivial: journals were only available in hard copies in the libraries and if your university library didn't have the subscription to a particular journal, you'd have to request an interlibrary loan and wait for (gasp!) weeks to get your hands on the paper you want to read. We are now on the other end of the spectrum. You type something into a search engine and it helpfully returns a million results, some too general, some too specific, some entirely inappropriate (if you want to look up "domination in graphs", it is safer to include the whole phrase).



As experts, we know what to look for in a mathematical resource in terms of difficulty level and exposition and how to quickly judge the credibility of the source. But what if you are new to the area? Think of a high school student looking for non-standard math to challenge them or a teacher trying to support their gifted and interested students outside of class and school curriculum? Hopefully, they can find a reliable source of trustworthy origin with relevant materials.

This is where *Crux* comes in. Sometimes I get asked “Why do we need another problem solving journal?”. *Crux* isn’t another problem solving journal; it is the problem solving journal. It has been around since March 1975 (I haven’t even been around for that long!), but age is only one of its most impressive virtues. High quality, consistency and relevance is what sets *Crux* apart. All of these qualities are the achievements of the people behind the publication, both editors and readers.

I never get tired of speaking highly of my editorial board because these people are simply amazing at what they do. Here is a conversation about one of the proposals we received that occurred last month:

Editor 1: This type of problems abound in the literature. In particular, on Putnam many years ago (though I can not recall the exact years (1967?) as I have left my Putnam books in the office).

Editor 2 (replying less than an hour later): You mean the one with the integral of $1/(1 + (\tan x)^{\sqrt{2}})$?

Exercise for the reader: compute $\int_0^{\pi/2} 1/(1 + (\tan x)^{\sqrt{2}}) dx$.

This journal has been through some hard times, but it has always provided materials worthy of the CMS seal of approval and it continues to do so. All the hard work put in by the editors, current and past, and the CMS head office is paying off as *Crux* is now

healthier than ever and picking up speed. We are finally out of backlog (yay!) and we receive more and more submissions. We publish 100 reader-proposed problems per year, but last year alone we received 780 problem proposals (up from 321 proposals in 2015). Articles received now will have to wait for 2018 to be published as all the 2017 spots are already spoken for. We are followed by over 6,000 people on Facebook (social media might not mean much, but 6,000 isn’t chump change).

Crux is a very dynamic publication as we draw the majority of the materials from our readers, so every issue is only superficially the same. Our readership is very diverse: from avid mature problems solvers to novices, from people in rural

India to problem solving groups in Canada and the US. Our audience is constantly expanding, both geographically and level-wise: in the previous Volume, *Crux* has received submissions by readers from every continent except Antarctica, while making more junior sections Open Access has attracted more submissions from high school students. So where do we go from here? Except for expanding into Antarctica, that is.

With enough support, *Crux* can become the go-to resource for more people interested in pursuing recreational or career mathematics. But we do need support: moral, with content and with funds. Moral support will go a long way in showing the Board that *Crux* is worth keeping around as it is, in fact, a good cause with far reach, impact and potential for more. Content support can be easily provided by submitting an article or a problem proposal to the journal. Finally, the money. The production of *Crux* requires administrative support. If you think that *Crux* is something you would personally like to donate money to, please consider doing so. If you know of a potential donor whose interests align with the purpose of this publication, please let me know.

Crux is more relevant and popular than ever both in spite of and because of the abundance of mathematics on the Internet. Reliable expert-supported mathematical resource is what is currently needed as we see more students going into sciences and would like to encourage them to give math a try. Our little purple book has a reputation that has been upheld for 43 years and continues to represent the very best of Canadian mathematical problem solving. It also represents the Society’s commitment to providing extracurricular activities for interested students and teachers, to supporting the problem-solving community and to outreach in general. So supporting it is the least we can do.

My email is crux.eic@gmail.com. Feel free to drop me a line about any of the above or any not of the above.

CMS Research Prizes

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

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

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

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

The deadline for nominations, including at least three letters of reference, is **September 30, 2017**. Nomination letters should list the chosen referees and include a recent curriculum vitae for the nominee. Some arms-length referees are strongly encouraged. Nominations and the reference letters from the chosen referees should be submitted electronically, preferably in PDF format, to the corresponding email address and **no later than September 30, 2017**:

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

Prix de recherche de la SMC

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

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

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

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

La date limite pour déposer une candidature, qui comprendra au moins trois lettres de référence, est **le 30 septembre 2017**. Le dossier de candidature doit comprendre le nom des personnes données à titre de référence ainsi qu'un curriculum vitae récent du candidat ou de la candidate. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, avant la date limite, à l'adresse électronique correspondante et **au plus tard le 30 septembre 2017** :

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

Research Notes brings mathematical research ideas forth to the CMS readership in a generally accessible manner that promotes discussion of relevant topics including research (both pure and applied), activities, and noteworthy news items. Comments, suggestions, and submissions are welcome.

Patrick Ingram, York University (notes-research@cms.math.ca)

Les articles de recherche présentent des sujets mathématiques aux lecteurs de la SMC dans un format généralement accessible qui favorise les discussions sur divers sujets pertinents, dont la recherche (pure et appliquée), les activités et des nouvelles dignes de mention. Vos commentaires, suggestions et propositions sont le bienvenue.

Patrick Ingram, York University (notes-recherche@smc.math.ca)

Rational Approximations of Algebraic Points

David McKinnon, University of Waterloo

In arithmetic, Your Highness, it is an ancient and venerable tradition that irrational numbers are dangerous and not to be trusted. So, naturally, when arithmeticians are required to solve an equation, they look for rational solutions.

Most people who believe in ancient and venerable traditions are cautious and conservative. Not wishing to buck the trend, I will concentrate on Diophantine equations (and systems of equations) whose rational solutions are plentiful, to minimise the risk."

"We approve of your determination to reduce risk, Lady Rouyn-Noranda, but what are these Diophantine equations of which you speak?"

"Forgive me, Your Highness: a Diophantine equation is simply a polynomial equation. There is a certain amount of innuendo associated with the term as well, but that is unsuitable for royal ears.

If I may have leave to continue? One way to generate lots of rational solutions to a system of Diophantine equations is to find polynomials with rational coefficients that are themselves solutions to the system. Plug in any rational number you like to the polynomial solution, and you get a rational solution. With a bit of luck, you get lots of rational solutions! In fact, you could replace the polynomials with rational functions, and the argument is unchanged.

But is this the only way? My cautious, conservative nature dislikes the idea of competition, and would prefer a monopoly. Is it true that any system with enough rational solutions must have a rational function solution as well?"

"Hardly a well posed question, I would say."

"Indeed, Your Majesty, that is true, so I must resort to vulgar precision. First, notice that the set of solutions to a system of Diophantine equations is a geometric object – a subset of $\mathbb{R}^n$ called an algebraic variety. And a rational function solution (in one variable) to that same system is a curve on that geometric object, called a rational curve. (Well, unless it's a single point.) So I can rephrase my earlier question: Is it true that any algebraic variety with enough rational points must have a rational curve on it?"

"Come, Lady! Your question is still not well posed. What does 'enough rational points' mean?"

"Indeed, Your Highness; I will specify. It turns out that 'infinitely many' is not enough, so I must define a notion of density. The height of a rational point $(x_1/y_1, \dots, x_n/y_n)$ is the absolute value of the largest numerator or denominator that appears, or as the downstairs staff would phrase it,

$$H(x_1/y_1, \dots, x_n/y_n) = \max\{|x_i|, |y_i|\}$$

(This formula is valid only when the fractions x_i/y_i are in lowest terms.) Obviously there are only finitely many rational points with bounded height, so we can ask how many of them happen to lie on our algebraic variety V .

If the answer is that at least B^ϵ rational points of height at most B lie on V (for some positive ϵ), then a conjecture of Manin (see [3]) states that there must indeed be a rational curve on V . This conjecture also (nearly) follows from the celebrated conjectures of Vojta (see [6] and [1]) and standard conjectures in the Minimal Model Program."

"Bah! To say that the Baron's conjecture follows from the Earl's is really only pointing out that something we don't know is slightly less likely than something else we don't know."

"Er, quite so, Your Majesty. If I may continue?"

These arguments are global, and the truly cautious person might want to restrict their attention to their immediate neighbourhood. If there are 'enough rational points' near a point P , for example, does it follow that there is a rational curve through P ?

Again, our ignorance is overwhelming, but my optimism is undimmed. A conjecture of McKinnon says that this indeed should be true, as long as the point P is itself rational. The conjecture has been proven in many cases, and in many others it follows from the same celebrated conjectures of Vojta that were so prominent earlier. (See [2] and [4] for the vulgar details.) More precisely, if there are infinitely many rational points $P_1, P_2, \dots$ on V such that $H(P_i) \text{dist}(P_i, P)^\alpha$ tends to a finite limit for some positive α , then the conjecture states that there is a rational curve through P that lies on V .

"That last condition is impenetrable! It smacks of the lower classes."

"Indeed, Your Highness, but I can make matters more plain. If a point P_i is to approximate a point P well, then it must have small height – that is, it must take little effort to write down – and it must be close to P . For example, the point $1/N$ approximates the point 0 quite well: the distance is a mere $1/N$, while the height is a trifling N . In this case, one may take $\alpha = 1$ in the condition above:

the product of the height and the distance is roughly constant in terms of the height bound N .

But sadly, approximations may not always be so efficient, doubtless due to Bolshevism. In such a case, it may be necessary to raise the (presumably very small) distance to a large power – namely α – in order for the product of distance and height to be roughly constant. This α may be considered the cost of approximating P , in a certain sense, and the larger the necessary α , the worse the approximations are to P .

“Hmm. And is this cost always affordable?”

“Alas no, Your Majesty. On an elliptic curve, for example, there is no such α , because there are so few rational points with small height. This is the essential content of the well known theorem of Siegel ([5]). Notice though, that an elliptic curve contains no rational curves, and so the conjectures are all satisfied.”

“Well, I am not satisfied! I’m afraid I cannot fund your scheme, Lady Rouyn-Noranda. An infinite cost is too much to bear for a royal purse that is already strained to the limit by this interminable conflict with the intuitionists. You may go. And don’t come back until you find something to help with the war effort. The Excluded Middle, preferably, dead or alive!”

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Retrouvailles de l’Équipe Math Canada à l’OIM le 29 juin

Des retrouvailles des anciens membres de l’Équipe Math Canada auront lieu le jeudi 29 juin lors de la réception pour souligner le départ de l’Équipe Math Canada qui participera à la 58^e Olympiade internationale de mathématiques à Rio de Janeiro, au Brésil.

La **réception prédépart de l’équipe de l’OIM** se déroulera de 11 h 30 à 12 h 30 et le dîner est prévu de 12 h 30 à 14 h.

La réception sera suivie d’une **discussion de groupe informelle** (de 14 h à 16 h) sur les moyens de sensibiliser la population à l’importance des mathématiques pour l’avenir du Canada.

Nous vous convions ensuite à **19 h à un souper informel au Bar Mercurio**, au 270, rue Bloor Ouest, Toronto, M5S1V8.

Un groupe de chambres a été réservé au **Holiday Inn Bloor-Yorkville**. Le prix est de 175 \$, ce qui est le meilleur tarif disponible. Vous pouvez réserver une chambre en composant le 1-877-859-5897 et en mentionnant le code de réservation **IMO**.

Pour plus d’informations, veuillez communiquer avec David Rodgers à drodgers@cms.math.ca.



Heisenberg Categorification

Alistair Savage, *Department of Mathematics and Statistics, University of Ottawa*

The Heisenberg Algebra

Heisenberg algebras play a fundamental role in mathematics and mathematical physics. The *Heisenberg algebra* is the unital associative $\mathbb{C}$ -algebra with generators $p_n, p_n^*, n \in I$, and relations

$$\begin{aligned} p_n p_m^* &= p_m^* p_n + \delta_{n,m} 1, & p_n p_m &= p_m p_n, \\ p_n^* p_m^* &= p_m^* p_n^*, & n, m &\in I. \end{aligned} \quad (1)$$

The size of the index set I is called the rank of the Heisenberg algebra. The first relation in (1) is often called the *canonical commutation relation* in the physics literature, where the generators p_n^* and p_n correspond to position and momentum operators in a single particle system with $|I|$ degrees of freedom. The Heisenberg algebra is also crucial in the study of the quantum harmonic oscillator.

The infinite-rank version of the Heisenberg algebra, where $I = \mathbb{N}$, is of central importance in quantum field theory and in the representation theory of infinite-dimensional Lie algebras. It also plays a vital role in the theory of symmetric functions. Indeed, let Sym denote the ring of symmetric functions over $\mathbb{C}$ and let $\langle \cdot, \cdot \rangle$ be the inner product on Sym under which the Schur functions are orthonormal. Then the infinite-rank Heisenberg algebra H is the subalgebra of $\text{End}_{\mathbb{C}} \text{Sym}$ generated by multiplication by elements of Sym , together with the adjoints of these operations. The tautological action of H on Sym is called the *bosonic Fock space representation*. Any choice of generating set for Sym yields a presentation of H . In particular, choosing the power sums recovers the presentation (1).

The Symmetric Group

Let S_n be the symmetric group of permutations of the set $\{1, 2, \dots, n\}$. One can naturally identify S_n with the subgroup of S_{n+1} fixing $n+1$. This gives rise to restriction and induction functors

$$\begin{aligned} \text{Res}: S_{n+1}\text{-mod} &\rightarrow S_n\text{-mod}, \\ \text{Ind}: S_n\text{-mod} &\rightarrow S_{n+1}\text{-mod}. \end{aligned}$$

The idea that one should consider the representation theory of S_n for all n simultaneously, related by these induction and restriction functors, leads to the theory of Gelfand–Tsetlin bases and the Okounkov–Vershik approach to the representation theory of the symmetric group.

It is not difficult to show that there is a natural isomorphism of functors

$$\text{Ind} \circ \text{Res} \cong (\text{Res} \circ \text{Ind}) \oplus \text{id}.$$

This isomorphism is a categorical analogue of the canonical commutation relation described above. It is the first indication

of a deep relationship between the Heisenberg algebra and the representation theory of the symmetric group and related algebras.

Heisenberg Categories

In a landmark paper, Khovanov defined a monoidal category $\mathcal{H}$ that acts naturally on the category of representations of symmetric groups [6]. The tensor product in $\mathcal{H}$ equips its Grothendieck group with a multiplication, making it an algebra. This Grothendieck group $K_0(\mathcal{H})$ contains, and is conjecturally isomorphic to, the Heisenberg algebra H . The category $\mathcal{H}$ is defined in terms of planar braid-like diagrams. Isotopy invariance of the diagrams corresponds to the fact that induction and restriction are both left and right adjoint to each other. In fact, the category $\mathcal{H}$ can, in some way, be thought of as a graphical calculus describing induction and restriction, together with the natural transformations between their compositions. Many important concepts in the representation theory of symmetric groups, such as Jucys–Murphy elements, the center of the group algebra $\mathbb{C}S_n$, and the Farahat–Higman ring have natural interpretations in the graphical calculus of $\mathcal{H}$.

Khovanov's construction has led to various generalizations. Replacing symmetric groups by Hecke algebras of type A leads to a q -deformation of Khovanov's category [9]. On the other hand, one can also replace symmetric groups by *wreath product algebras*, which are algebras of the form $B^{\otimes n} \rtimes \mathbb{C}S_n$, where B is a finite-dimensional algebra, and S_n acts on $B^{\otimes n}$ by permutation of the factors. (Taking $B = \mathbb{C}$ recovers Khovanov's category.) The resulting generalizations $\mathcal{H}_B$ of Khovanov's category $\mathcal{H}$ also categorify the Heisenberg algebra but in a different presentation [2],[11].

Applications and Open Questions

Heisenberg categories have been shown to have deep connections to representation theory, geometry, and algebraic combinatorics. For certain choices of algebra B , the categories $\mathcal{H}_B$ act on derived categories of coherent sheaves on Hilbert schemes of points on resolutions of singularities of $\mathbb{C}^2/\Gamma$, where Γ is a finite subgroup of $\text{SL}_2(\mathbb{C})$ [2]. The algebra B in this case is the so-called *zigzag algebra* associated to Γ .

The algebra H plays a vital role in the theory of affine Lie algebras. In particular, one can use the Fock space representation of H to construct the so-called *basic representation* of an affine Lie algebra $\widehat{\mathfrak{g}}$ via vertex operators. In fact, there are many variations of this construction, one for each element of the Weyl group of $\mathfrak{g}$. The two extreme cases are known as the *homogeneous* and *principal* realizations. These constructions have been categorified, linking Heisenberg categories to categorified quantum groups [2],[10]. The categorification of the other constructions is still open.

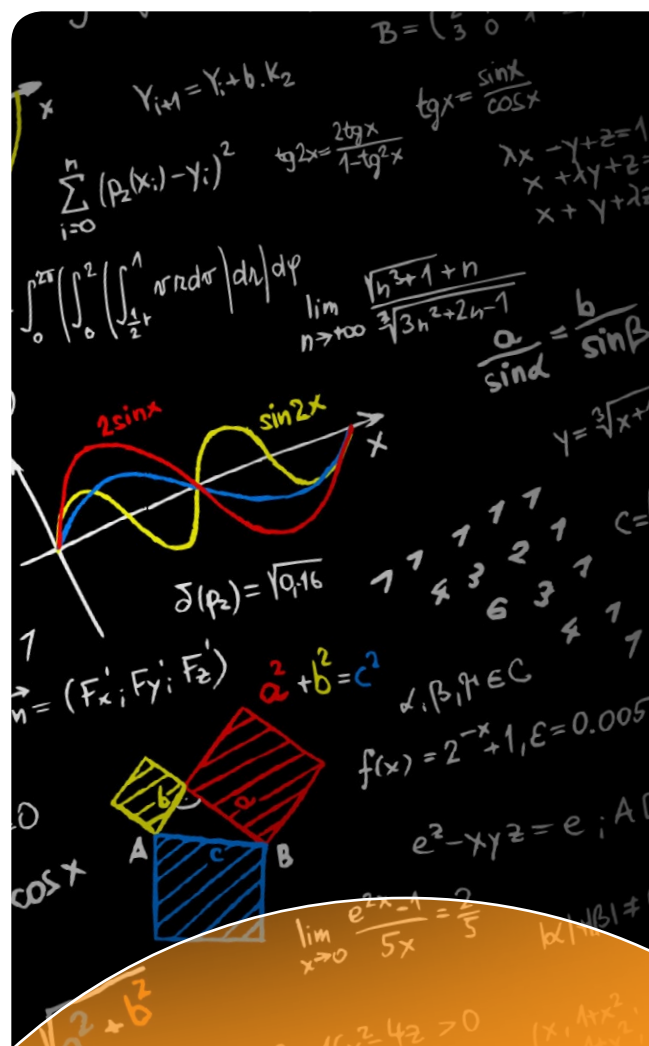
When we say that $\mathcal{H}_B$ categorifies the algebra H , we are asserting a relationship between H and the Grothendieck group of $\mathcal{H}_B$. However, rather than passing to the Grothendieck group, there is another way to “decategorify” a monoidal category: one can take the trace, or Hochschild homology, of the category. The trace of

Khovanov's original category $\mathcal{H}$ has been related to W -algebras [4], while the trace of its q -deformation is connected to elliptic Hall algebras [4]. It would be interesting to investigate the traces of the general categories $\mathcal{H}_B$, which should also be related to W -algebras.

Heisenberg categories can also be used to categorify many concepts related to symmetric functions. In particular, the category $\mathcal{H}$ has been related to shifted symmetric functions and moments in free probability [7], while the more general categories $\mathcal{H}_B$ have been used to categorify the inner product on symmetric functions used to define the important *Jack symmetric functions* [8]. In addition, categorical versions of Schur functions, elementary symmetric functions, complete symmetric functions, and power sum symmetric functions all appear in Heisenberg categorification. In fact, these connections suggest that many natural objects and constructions in the theory of symmetric functions are shadows of higher categorical analogues. This is currently an active area of research and we expect many exciting developments in the coming years.

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Les articles de la SCHPM présente des travaux de recherche en histoire et en philosophie des mathématiques à la communauté mathématique élargie. Les auteurs sont membres de la Société canadienne d'histoire et de philosophie des mathématiques (SCHPM). Vos commentaires et suggestions sont le bienvenue; ils peuvent être adressées à l'une des co-rédacteurs:

Amy Ackerberg-Hastings, Chercheuse indépendante

(aackerbe@verizon.net)

Hardy Grant, York University [retraité] (hardygrant@yahoo.com)

Bertrand Russell Archives at McMaster University

David Orenstein, Danforth Collegiate and Technical Institute [retired]

It's an easy trip from my home in downtown Toronto to Hamilton's McMaster University, whose William Ready Division of Archives and Research Collections houses the Bertrand Russell (1872–1970) Archives, www.mcmaster.ca/russdocs/russell.htm. Almost all of its material was acquired directly from Russell in 1968 or from his estate in 1972. The holdings are immensely broad and deep in form as well as in content, including Russell's books, published papers, manuscripts, correspondence, library, and personal objects. His mathematical and political writing are both exceptionally well documented.

Because the collection is so vast, it has its own search engine on the McMaster Library website, Bertrand Russell Archives Catalogue Entry and Research System (BRACERS, bracers.mcmaster.ca/) And, again due to its large size, readers can consult in one place almost any of Russell's published works alongside that book's or article's preliminary materials, such as research notes or manuscripts. This is the case for Russell's first two books: *German Social Democracy* (1896) and *An Essay on the Foundations of Geometry* (1897). Only *Foundations* has annotations, mostly in the form of short marginal corrections. One of the longest occurs on p. 131 in the right margin: "No! If str. Lines differ qualy. So do pts. — if str. Lines do not differ qualy. The argument is nugatory".

In one manuscript notebook, entitled "Observations on Space and Geometry" and dated "March 6 — June 1895", the first 75 recto pages are on that topic. The versos have notes in German from Schmöller's *Prussian History*. Another notebook starts with "Notes for a lecture on the Political Teachings of German Social Democracy" and then continues with "Notes for 'The a priori concepts of Mathematics'". A researcher thus finds tools to try to understand Russell's methods.

Through a glass wall from the Reading Room visitors can see Russell's desk and the books from his personal library, arranged in their original order. One section is referred to as "Russell's EX Library"—the books he had left at the homes of his ex-wives. Russell's personal copy of the 1944 first edition of *The Philosophy*

of Bertrand Russell, edited by Paul Schlipp, maintains the original thick black leather binding with the elegant gold lettering and simple decoration. It shows signs of use, but (alas) I could find no annotations. I did read the chapter containing Russell's response to his critics; especially noteworthy was his praise of the recent work of Kurt Gödel. I also read Albert Einstein's short essay on the roots of scientific knowledge, reading both sides of the facing-pages German-English presentation.

The earliest sources in the Archives are Russell's ancestral papers. His paternal grandfather was Lord John Russell (1792–1878), who kept a short (four-page) "Diary of a Prime Minister": "Aug 29 [1849] ... Breakfasted with the Duke of Leeds. At ten o'clock Cpt. Phips. and I ... set out deer-stalking. ... Aug. 30 ... 9 miles with Mr. Ricardo ... killed between us 15 brace of grouse." A small lithograph tip-in depicts Queen Victoria's Balmoral Castle. Another journal was kept by Russell's father, Lord Amberley, in 1860:

Pembroke Lodge ... Th. [January] 5. [1860] ...

Mr. Gladstone came down to stay till Saturday ... We all found him exceedingly pleasant. I am very glad to have made his acquaintance.

The vast trove of original correspondence is housed in archival boxes designed to absorb the acid from the paper. One extensive exchange was between Russell and his elder brother Frank, who first succeeded to the earldom. When Russell was in Brixton Prison for pacifist agitation in 1918, Frank was his key contact. For instance, on 6 May Russell wrote to Frank that

Everybody treats me kindly from the Governor downwards ... I shall write first a book called 'Introduction to Modern Logic' ... Conditions here are good for philosophy, but there are still very few books for me ... Prison has some of the same advantages as the Catholic Church ... I am remarkably happy; more so than I have been for years.

The next day Frank replied: "I look with terror on the prospect of your cultivating your mind even further ... [Y]our philosophical friends will enjoy the horrors you will produce in Brixton."

Russell's Early (Pre-WWI) Congresses

My own interests lie in international mathematics conferences held in Canada, so I have looked especially at Russell's participation in these meetings. Russell did not attend the History, Philosophy and Didactics section of the 1924 International Mathematical Congress at the University of Toronto. However, he did participate in the 1912 International Congress of Mathematicians held at his own Cambridge University. He attended the 1908 ICM in Rome but did not deliver a paper.

Russell's personal copy of the two-volume *Proceedings of the Fifth International Congress of Mathematicians Cambridge, 22–28 August 1912*, is in the Russell Library. For correspondence regarding Russell's Congresses I had two tactics for searching BRACERS. One was to use the keyword "Congress"; the other was to search for items dated August 1912. Thus, I found that on January 27, 1912, E.W. Hobson, Cambridge's Sadlerian Professor of Pure Mathematics and General Secretary of the Congress, wrote Russell:

The Committee which is organising the Mathematical Congress for August next hopes that you may be ... one of the 'Introducers' for Section IV (Philosophical, historical and didactical questions) ... The duty ... is to send out to people, whom he may select, a printed letter ... which he will sign, suggesting [they] may offer Communications at the sectional Meetings.

The answers that Russell received included one from R.F. Muirhead (Emmanuel College, Glasgow) dated July 11, 1912. After reminding Russell that they had met at the 1908 Rome ICM, Muirhead wrote, "I am offering a paper on the principle of superposition ... as the logical basis of geometry to the Congress at Cambridge ... [S]uperposition gives a sound logical basis for Geometry and for the mathematics of continuous quantity."

During the Congress Russell continued his daily letters to his lover, Ottoline Morrell, including this note penned on August 23, 1912:

At 9.15 I had to be at the Congress ... From 9.30 to 1 I was in the chair, trying to get men not to exceed their 20 minutes ... occasionally getting into terrific arguments with Frenchmen, Germans, Italians, Russians etc. Then I lunched with 3 Italians ... Then I had a breathing space and walked with Whitehead – the Dean of Bryn Mawr (a Miss Reilly ...) came to tea; then a fierce young Italian ... Padoa – with whom I had differences ... : 2 hours of argument, exhortation, vituperation ... – but we were really excellent friends and parted on the best of terms. I really enjoyed my day tho' I am half dead.

The Archives' Activities

The Bertrand Russell Archives has been publishing the journal *Russell* since 1971 in one form or another, now including an on-line presence; see library.mcmaster.ca/news/2943. For example, Marilyn Mason's paper "'The Sins of Civilisation': Bertrand

Russell in Toronto", appeared in 1983. She began by reprinting an advertisement from the Toronto *Globe* for Russell's December 6, 1931, lecture. The same issue contains a short review by Ivor Grattan-Guinness of three books in three different languages (Russian, German, and English) that exemplified "Recent researches in the mathematical Russell". Grattan-Guinness also edited *Dear Russell-Dear Jourdain*, the correspondence of Bertrand Russell and Phillip Jourdain, of course from the holdings of the Archives. Such publishing of the correspondence and papers of Russell is a major activity of the archive.

Despite being based at McMaster almost half a century, the Bertrand Russell Archives are still growing. The staff receives donations but is also engaged in the active search for new material. For instance, Gustav Kirchhoff's *Vorlesung uber mathematische Physik*, with Russell's marginalia, has just joined the Russell Library. The Archives has also recently received Russell's suit and pipe. The institution will be celebrating its 50th Anniversary in 2018. But that's another story.

David Orenstein (david.orenstein@utoronto.ca) is in his fifth year of retirement from teaching mathematics at an inner-city Toronto high school. Inclement days can now be spent in archival research into the history of Canadian mathematics and science, and more welcoming ones in the parks and on the patios.

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La SMC cherche un secrétaire exécutif

La Société mathématique du Canada est actuellement à la recherche d'une personne enthousiaste, sachant faire preuve d'initiative et très désireuse de soutenir le développement de la communauté mathématique du Canada, pour pourvoir le poste de secrétaire exécutif.

La SMC s'efforce de promouvoir la découverte, l'apprentissage et l'application des mathématiques au Canada. Elle améliore la pratique des mathématiques au Canada grâce à des congrès nationaux et à la publication de revues de recherche, de livres et de bulletins d'information en format imprimé et électronique. Avec l'aide de bénévoles, la SMC appuie les efforts destinés à identifier et à former de jeunes mathématiciens grâce à des concours et à des camps mathématiques, sans oublier d'autres activités éducatives. Le travail de la SMC est effectué par un grand nombre de bénévoles dévoués et enthousiastes, et un personnel expérimenté restreint, composé de huit personnes au bureau administratif d'Ottawa.

Le rôle du secrétaire exécutif est de soutenir le président de la SMC (en collaboration avec le Comité exécutif et les présidents des comités permanents) et d'assurer la liaison entre eux et le personnel du bureau administratif. Il s'agit d'un poste à mi-temps. Le secrétaire exécutif ne doit pas forcément être basé à Ottawa, puisqu'une partie des tâches pourrait être gérée à distance. S'il est situé ailleurs, il doit être en mesure de se déplacer facilement vers la capitale, puisqu'il devra passer au moins une journée par semaine au bureau administratif de la SMC.

Pour ceux qui connaissent l'histoire de la SMC, il s'agissait d'un poste à temps plein (directeur exécutif) et les fonctions étaient différentes, à savoir l'administration du bureau administratif. La restructuration de la SMC signifie que le personnel du bureau administratif gère désormais la plupart des activités indépendamment. Le poste de secrétaire exécutif vise plutôt à fournir un contact unique pour faciliter la mise en œuvre des décisions politiques du président de la SMC et du Comité exécutif par l'intermédiaire du bureau administratif.

Le nouveau secrétaire exécutif possèdera à la fois une expérience administrative et une vaste connaissance de la communauté mathématique canadienne. Un doctorat en mathématiques est nécessaire, ainsi que d'excellentes capacités d'organisation, de communication interpersonnelle et de résolution de problèmes. Les exigences détaillées sont énumérées dans la [description de l'emploi en ligne](#).

Ce poste est idéal pour quelqu'un qui cherche à passer d'un emploi universitaire à temps plein à un emploi à mi-temps. La SMC est également prête à étudier la possibilité d'un détachement à mi-temps d'un poste universitaire à temps plein (ou d'un paiement forfaitaire).

Ce poste représente une occasion unique de soutenir la Société mathématique du Canada et d'améliorer la communauté mathématique canadienne. Il s'agit d'un emploi varié et flexible nécessitant à la fois une vision et des talents en administration.

Les candidatures, y compris les lettres d'accompagnement, le curriculum vitae et les références doivent nous parvenir avant **le 23 juin 2017** puisque leur examen commencera tout de suite après cette date.

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21. Harmonic Analysis and Inverse Problems | Analyse harmonique et problèmes inverses
22. Geometric Analysis | Analyse géométrique
23. Applied and Computational Algebra and Geometry | Algèbre et géométrie appliquées et computationnelles
24. Hamiltonian Systems and Celestial Mechanics | Systèmes hamiltoniens et mécanique céleste
25. Morse, Conley, and Forman Approaches to Smooth and Discrete Dynamics | Approches de Morse, Conley et Forman en dynamique smooth et discrète
26. Calabi-Yau Manifolds and Calabi-Yau Algebra | Variétés et algèbre de Calabi-Yau
27. Computational Inverse Problems: From Multiscale Modeling to Uncertainty Quantification | Problèmes computationnels inverses : de la modélisation multi-échelle à la quantification de l'incertitude
28. Gauge Theory and Special Geometry | Théorie de jauge et géométrie spéciale
29. Symmetry in Algebra, Topology, and Physics | La symétrie en algèbre, en topologie et en physique
30. Von Neumann Algebras and their Applications | Algèbres de Von Neumann et leurs applications
31. Arithmetic Dynamics | Dynamique arithmétique
32. Holomorphic Foliations and Singularities of Mappings and Spaces | Foliations holomorphes et singularités des représentations et des espaces
33. Singularities and Phase Transitions in Condensed Matter | Singularités de la matière condensée et transitions de phases
34. Discrete Groups and Operator Algebras | Groupes discrets et algèbres des opérateurs
35. Recent Trends in Algebraic Cycles, Algebraic K-Theory and Motives | Dernières tendances en cycles algébriques, K-théorie algébrique et motifs
36. Nonlinear Partial Differential Equations | Équations aux dérivées partielles (EDP) non linéaires
37. Nonlocal Variational Problems | Problèmes variationnels non locaux
38. Advances in Analysis, PDE's and Related Applications | Progrès en analyse, EDP et applications connexes
39. Nonlinear Dispersive Equations | Équations dispersives non linéaires
40. Mathematical Physics | Physique mathématique
41. Stringy Geometry | Géométrie des cordes
42. Quantitative Geometry and Topology | Géométrie et topologie quantitatives
43. Fractal Geometry and Dynamical Systems | Géométrie fractale et systèmes dynamiques
44. Optimization and Control | Optimisation et contrôle
45. Extremal and Probabilistic Combinatorics | Combinatoire extrême et probabiliste
46. Geometry of Differential Equations, Real and Complex | Géométrie des équations différentielles, réelles et complexes
47. Current Trends in Combinatorics | Tendances actuelles en combinatoire
48. Cohomology of Groups | Cohomologie des groupes
49. Classification of Amenable C^* -algebras | Classification des algèbres C^* moyennables
50. Geometry and Physics of Higgs Bundles | Géométrie et physique des bundles de Higgs
51. Incompressible Fluid Dynamics | Dynamique des fluides incompressibles
52. Nonlinear and Stochastic Partial Differential Equations | Équations aux dérivées partielles non linéaires et stochastiques
53. Models and Methods in Evolutionary Differential Equations on Mixed Scales | Modèles et méthodes en équations différentielles évolutives sur échelles mixtes
54. Interactions Between Geometric Group Theory, Low-Dimensional Topology and Geometry, and Dynamics | Interactions entre la théorie des groupes géométrique, la topologie et la géométrie en basse dimension et la dynamique
55. Equations of Fluid Mechanics: Analysis | Équations de la mécanique des fluides : analyse
56. Equations of Fluid Mechanics: Numerics | Équations de la mécanique des fluides : nombres
57. Geometry and Combinatorics of Cell Complexes | Géométrie et combinatoire des complexes cellulaires
58. Recent Advance in Disease Dynamics Analysis | Progrès récents en analyse de la dynamique des maladies
59. Free Probability and its Applications | Probabilité libre et ses applications
60. Groups and Algebras | Groupes et algèbres
61. Shape, Homotopy, and Attractors | Forme, homotopie et attracteurs
62. Topological Dynamics and Operator Algebras | Dynamique topologique et algèbres d'opérateurs
63. Mathematics of Quantum Phases of Matter and Quantum Information | Mathématiques des phases quantiques de la matière et de l'information quantique
64. Advances in Arrangement Theory | Progrès en théorie des arrangements
65. Number Theory & Analysis | Théorie des nombres et analyse
66. Spectrum and Dynamics | Spectre et dynamique
67. Quantum Walks, Open Quantum Walks, Quantum Computation and Related Topics | Marches quantiques, marches quantiques ouvertes, calcul quantique et sujets connexes
68. Advances in Algebraic and Analytic Number Theory | Avancées en théorie des nombres algébrique et analytique
69. Noncommutative Geometry and Quantization | Géométrie non commutative et quantification
70. Symmetries of Symplectic Manifolds and Related Topics | Symétries des variétés symplectiques et sujets connexes
71. Galois Representations and Automorphic Forms | Représentations de Galois et formes automorphes
72. Geometric Group Theory | Théorie des groupes géométriques
73. CMS-Studc Student Research Session | Session de recherche étudiante - SMC-Studc



CMS Executive Meeting

Saturday July 22nd: 4:00 pm - 7:00 pm
Marriott Château Champlain, Terrasse Meeting Room

CMS Executive and Board Information Session

Sunday July 23 from 11:00 am to 2:00 pm

CMS AGM Lunch

Tuesday July 25th: 1:00 pm - 2:30 pm
Centre Mont-Royal, Salon International E

CMS Prize Lectureships

Sunday July 23rd: 3:30 pm - 4:30 pm
Sunday July 23rd: 7:00 pm - 8:00 pm
Centre Mont-Royal, Auditorium

MCA Welcome Reception

Sunday July 23rd: 5:00 pm - 7:00 pm

CMS Committee Meetings

All Committee meetings can be held at the Marriott Château Champlain from July 22nd to July 28th from 7:00 am to 10:00 pm.

To book a time for your committee to meet, please contact Sarah Watson (meetings@cms.math.ca).

Once booked, your committee meeting will be posted on the MCA site.

Plenary Speakers



Manuel del Pino,
Universidad de Chile



Shafira Goldwasser,
MIT, USA



Andrew Granville,
Université de Montréal



Peter Ozsvath,
Princeton University



Yuval Peres, Microsoft
Research, USA

Cecilia String Quartet Concert at McGill's Pollack Hall

As part of a wider cultural programme, the conference has booked McGill's Pollack Hall for a performance of the Cecilia Quartet, a prize-winning and up and coming string quartet (<http://ceciliastringquartet.com>).

July 25, 2017 at 8:00 pm

Tickets are \$10.

Hailed for their "powerful" (Chicago Sun-Times) and "dauntingly perfect" (Berliner Zeitung) performances, the CSQ perform for leading presenters in North America and Europe. Past engagements include performances at the Amsterdam Concertgebouw, Berlin Konzerthaus, Northwestern University in Illinois, Buffalo Chamber Music Society, and London's Wigmore Hall. Their live concert recordings have been broadcast on more than a dozen international public radio networks, including Australia (ABC Classical FM), Canada (CBC/SRC), the United States (WQXR), England (BBC Radio 3), and Germany (DeutschlandRadio). Prize-winners at several international competitions, including Osaka (2008) and Bordeaux (2010), they were awarded First Prize at the 2010 Banff International String Quartet Competition (BISQC), where they also won the prize for the best performance of the commissioned work.



Réunion du comité exécutif de la SMC

Samedi 22 juillet : 16 h - 19 h
Marriott Château Champlain, Salle de réunion Terrasse

Comité exécutif de la SMC et séance d'information du Conseil

Dimanche 23 juillet : 11 h - 14 h

Dîner de l'AGA de la SMC

Mardi 25 juillet : 13 h - 14 h 30
Centre Mont-Royal - Salon International E

Conférences des lauréats de prix de la SMC

Dimanche 23 juillet : 15 h 30 - 16 h 30
Dimanche 23 juillet : 19 h - 20 h
Centre Mont-Royal - Auditorium

Réunions des comités de la SMC

Toutes les réunions de comités peuvent se tenir à l'hôtel Marriott Château Champlain entre le 22 et le 28 juillet, de 7 h à 22 h.

Pour réserver une date pour votre comité, veuillez contacter Sarah Watson (reunions@smc.math.ca).

Une fois la réservation faite, la réunion de votre comité sera publiée sur le site du CMA.

Réception de bienvenue CMA

Dimanche 23 juillet : 17 h - 19 h

Conférenciers pléniers



Manuel del Pino,
Université du Chili



Shafira Goldwasser,
MIT, États-Unis



Andrew Granville,
Université de Montréal



Peter Ozsvath,
Université de Princeton



Yuval Peres, Microsoft
Research, États-Unis

Concert du Cecilia String Quartet à la salle Pollack de l'Université McGill

Dans le cadre d'un programme culturel élargi, les organisateurs ont réservé la salle Pollack de l'Université McGill pour un spectacle du Cecilia Quartet, un quatuor à cordes primé et à la popularité montante (<http://ceciliastringquartet.com>).

Le 25 juillet 2017 : 20 h

Coût du billet : 10 \$

Salué pour ses spectacles « d'une grande puissance » (*Chicago Sun-Times*) et « d'une perfection terrifiante » (*Berliner Zeitung*), ce quatuor se produit avec des sommités en Amérique du Nord et en Europe. Il a notamment joué avec au Concertgebouw d'Amsterdam, Konzerthaus de Berlin, à l'Université Northwestern en Illinois, à la Buffalo Chamber Music Society et au Wigmore Hall à Londres. Leurs enregistrements de concerts en direct ont été diffusés sur plus d'une dizaine de réseaux de radio publics internationaux, notamment en Australie (ABC Classical FM), au Canada (CBC/SRC), aux États-Unis (WQXR), en Angleterre (BBC Radio 3) et en Allemagne (DeutschlandRadio). Lauréat de plusieurs concours internationaux, dont Osaka (2008) et Bordeaux (2010), le quatuor a reçu le premier prix de l'International String Quartet Competition de Banff, où il a également remporté le prix de la meilleure performance de l'œuvre commandée.

**December 8-11, 2017**

University of Waterloo – Waterloo, Ontario

cms.math.ca/Events/winter17**Prizes | Prix**

2017 Excellence in Teaching Award | Prix d'excellence en enseignement

Recipients to be announced | Lauréats à confirmer

2017 Adrien Pouliot Award | Prix Adrien-Pouliot

Recipients to be announced | Lauréats à confirmer

2017 Coxeter-Jame Prize | Prix Coxeter-James et conférence

Recipients to be announced | Lauréats à confirmer

2017 Doctoral Prize | Prix de doctorat

Recipients to be announced | Lauréats à confirmer

2017 Graham Wright Award for Distinguished Service
| Prix Graham Wright pour service méritoire

Recipients to be announced | Lauréats à confirmer

2017 G. de B. Robinson Award | Prix G. de B. Robinson

Recipients to be announced | Lauréats à confirmer

Scientific Directors | Directeurs scientifique

Kenneth Davidson, University of Waterloo

Cameron Stewart, University of Waterloo

8-11 décembre 2017

Université de Waterloo – Waterloo, Ontario

cms.math.ca/Reunions/hiver17**Plenary Lectures | Conférences plénières**

Bill Cook, University of Waterloo

Ilijas Farah, York University

Joel Kamnitzer, University of Toronto

Niky Kamran, McGill University

Natalia Komarova, UC-Irvine

Public Lecture | Conférence publique

Edward Burger, Southwestern University

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Regular Sessions | Sessions générales

Algebraic Graph Theory | Théorie algébrique des graphes

Org: Chris Godsil (University of Waterloo)

Analytic Number Theory | Théorie analytique des nombres

Org: Kevin Hare, Wentang Kuo and Yu-Ru Liu (University of Waterloo)

Application of Mathematics to Medicine & Biology | Application des mathématiques à la médecine et à la biologie

Org: Sivabal Sivaloganathan (University of Waterloo)

Applications of Combinatorial Topology in Commutative Algebra | Applications de la topologie combinatoire en algèbre commutative

Org: Sara Faridi (Dalhousie University) and Adam Van Tuyl (McMaster University)

Arithmetic Dynamics | Dynamique arithmétique

Org: Jason Bell (University of Waterloo) and Patrick Ingram (York University)

Contributed Papers | Communications libres

Org: to be announced | Org : à venir

Cyclic homology and noncommutative geometry | Homologie cyclique et géométrie non commutative

Org: Masoud Khalkhali (Western University) and Ilya Shapiro (University of Windsor)

Design Theory | Théorie de la conception

Org: Hadi Kharaghani (University of Lethbridge) and Doug Stinson (University of Waterloo)

Dynamics of Microbial Systems | Dynamique des systèmes microbiens

Org: Gail Wolkowicz (McMaster University)

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

Org: Kevin Lamb, Francis Poulin and Marek Stastna (University of Waterloo)

Explicit finiteness of integral points on hyperbolic curves | Finitude explicite des points entiers sur les courbes hyperboliques

Org: David McKinnon (University of Waterloo) and Jerry Wang

Geometric Analysis | Analyse géométrique

Org: Benoit Charbonneau and Spiro Karigiannis (University of Waterloo)

History of Mathematics | Histoire des mathématiques

Org: Maritza M. Branker (Niagara University)

Logic and Operator Algebras | Logique et algèbres des opérateurs

Org: Ilijas Farah (York University) and Marcin Sabok (McGill University)

Low dimensional topology and geometric group theory | Topologie en basses dimensions et théorie des groupes géométriques

Org: Adam Clay (University of Manitoba) and Tyrone Ghaswala (University of Waterloo)

Mathematical aspects of quantum information | Aspects mathématiques de l'information quantique

Org: David Kribs, Rajesh Pereira and Bei Zeng (University of Guelph)

Model Theory | Théorie des modèles

Org: Rahim Moosa (University of Waterloo) and Sergei Starchenko (University of Notre Dame)

Operator algebras | Algèbres des opérateurs

Org: Matthew Kennedy (University of Waterloo) and Paul Skoufranis (York University)

Symmetric functions and generalizations | Fonctions symétriques et généralisations

Org: Angele Hamel (Wilfrid Laurier University) and Stephanie van Willigenburg (University of British Columbia)

Toric geometry | Géométrie torique

Org: Matthew Satriano (University of Waterloo) and Greg Smith (Queen's University)

Variational Analysis and Monotone Operator Theory | Analyse variationnelle et théorie des opérateurs monotones

Org: Heinz Bauschke and Xianfu Wang (University of British Columbia Kelowna)

Graduate Student Poster Session

Présentations par affiches pour étudiants

Org: to be announced | Org : à venir

Using Digital Assets in Mathematics Education and Outreach | Utiliser les outils numériques en éducation et en sensibilisation aux mathématiques

Brian and Barbara Forrest (Waterloo)

2018 David Borwein Distinguished Career Award

The **David Borwein Distinguished Career Award** recognizes mathematicians who have made exceptional, broad, and continued contributions to Canadian mathematics.

A complete nomination dossier consists of:

- A signed nomination statement from a present or past colleague, or collaborator (no more than three pages) having direct knowledge of the nominee's contribution;
- A short curriculum vitae, no than five pages;
- Two to four letters of support in addition to the nomination;
- Other supporting material may be submitted, no more than 10 pages.

A nomination can be updated and will remain active for three years.

The complete nomination dossier must arrive at the CMS Executive Office **no later than November 15, 2017**.

All documentation should be submitted electronically, preferably in PDF format, by the appropriate deadline, to dbaward@cms.math.ca.

Prix David-Borwein de mathématicien émérite pour l'ensemble d'une carrière 2018

Le **prix David-Borwein de mathématicien émérite pour l'ensemble d'une carrière** rend hommage à un mathématicien qui a fait une contribution exceptionnelle et soutenue aux mathématiques canadiennes.

Le dossier de candidature comprendra les éléments suivants :

- une lettre de mise en candidature signée par un collègue ou un collaborateur actuel ou des années passées (trois pages maximum) qui connaît très bien les réalisations de la personne proposée;
- un bref curriculum vitae, maximum de cinq pages;
- de deux à quatre lettres d'appui, en plus de la mise en candidature;
- tout autre document pertinent, maximum de 10 pages.

Toute mise en candidature est modifiable et demeurera active pendant trois ans.

Le dossier complet doit parvenir au bureau administratif de la SMC **au plus tard le 15 novembre 2017**.

Veuillez faire parvenir tous les documents par voie électronique, de préférence en format PDF, avant la date limite à prixdb@smc.math.ca.

2018 CMS Excellence in Teaching Award

The CMS Excellence in Teaching Award Selection Committee invites nominations for the **2018 Excellence in Teaching Award**.

The Excellence in Teaching Award recognizes sustained and distinguished contributions in teaching at the post-secondary undergraduate level at a Canadian institution. The award focuses on the recipient's proven excellence as a teacher at the undergraduate level as exemplified by unusual effectiveness in the classroom and/or commitment and dedication to teaching and to students.

Nomination letters, *including at least three letters of reference*, should list the chosen referees and include a recent curriculum vitae for the nominee, if available.

Nominations and reference letters should be submitted electronically, preferably in PDF format, to: etaward@cms.math.ca no later than the deadline of **November 15, 2017**.

Prix d'excellence en enseignement de la SMC 2018

La Comité de sélection du Prix d'excellence en enseignement de la SMC invite un appel de mises en candidatures pour le **Prix d'excellence en enseignement 2018**.

Le Prix d'excellence en enseignement récompense des contributions exceptionnelles et soutenues en enseignement au collégial et au premier cycle universitaire dans un établissement canadien. Le Prix récompense l'excellence reconnue d'un enseignant ou d'une enseignante au niveau postsecondaire telle qu'illustrée par son efficacité exceptionnelle en classe ou son engagement et son dévouement envers l'enseignement et les étudiants.

Le dossier de candidature, *comprenant au moins trois lettres de référence*, doit comprendre le nom des personnes données à titre de référence ainsi qu'un curriculum vitae récent du candidat ou de la candidate, dans la mesure du possible.

Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, à : prixee@smc.math.ca avant la date limite du **15 novembre 2017**.



Mathematics of Planet Earth () invites the scientific community to enter the Second International Competition to design museum exhibits on Mathematics of Planet Earth. This new competition is supported by the International Mathematical Union, UNESCO, the International Commission of Mathematical Instruction and IMAGINARY.

The competition will enrich the MPE Open Source Exhibition (<https://imaginary.org/exhibition/mathematics-of-planet-earth>), which provides material that can be used by museums and schools around the world. Exhibits can take the form of an interactive program, a hands-on physical exhibit, a short film, or an image gallery; and must address some planetary theme where mathematics plays a role. A special call is made for topics related to the African continent.

An international jury will award four prizes to the best modules:

- 1st, 2nd and 3rd prize: 5 000 USD, 2 000 USD, and 1 000 USD respectively.
- A special prize of 2 000 USD for the best exhibit addressing an African topic.

Participation is open until **June 30, 2017**. More information at

www.mathofplanetearth.org/competition.



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La Société mathématique du Canada (SMC) est fière d'annoncer...

Après 35 ans, le Congrès international de physique mathématique (CIPM) reviendra en Amérique du Nord en 2018 et se déroulera au Canada pour la première fois. Tenu tous les trois ans, le CIPM est l'événement le plus important de l'Association internationale de physique mathématique. Le XIXe CIPM aura lieu à Montréal en 2018 et, selon la nouvelle tradition, il sera précédé du Symposium des jeunes chercheurs. Ce Symposium se tiendra à l'Université McGill les 20 et 21 juillet, et le CIPM se déroulera au Centre Mont-Royal et à l'Université McGill du 23 au 28 juillet. Le Canada se réjouit à l'idée d'accueillir le monde de la physique mathématique en 2018!

Le CIPM 2018 sera organisé par la SMC en collaboration avec de nombreuses associations des domaines de la physique et des mathématiques, notamment : le CRM, l'Université McGill, le PIMS, l'Institut Fields, l'ISM, l'AARMA, le CANSSI, la SRIB, l'Institut Périmètre, l'Université de Montréal et l'UQAM.

<https://icmp2018.org/fr>

The Canadian Mathematical Society (CMS) is pleased to announce...

After 35 years, the International Congress on Mathematical Physics (ICMP) will return to North America in 2018, which will also mark the first time that Canada will host the congress. The ICMP, on its three year cycle, is the most important event of the International Association of Mathematical Physics. The XIXth ICMP will take place in Montreal, 2018, and, following recent tradition, it will be preceded by the Young Researchers Symposium (YRS). The YRS will be held at McGill University from July 20 to July 21 and the ICMP will be held at the Centre Mont-Royal and McGill University from July 23 to July 28. Canada is looking forward to welcoming the world of mathematical physics in 2018!

ICMP 2018 will be staged by the CMS in collaboration with many physics and mathematics organizations, including: CRM, McGill University, PIMS, FIELDS, ISM, AARMS, CANSSI, BIRS, Perimeter Institute, U. Montréal, and UQAM.

<https://icmp2018.org/en/welcome>

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