



## 2018 CMS Summer Meeting / Réunion d'été de la SMC 2018..... 13

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# CMS NOTES de la SMC

December / décembre  
2017

Vice-President's Notes / Notes de la Vice-présidente

**Malabika Pramanik (UBC)**

Vice-President - Pacific / Vice-présidente - Pacifique

## Fall, season of letters



**A**h, the joys of fall! Swirling leaves, nip in the air, vibrant colours, and ... penning innumerable letters. As much of the plant and animal Kingdom wind down and prepare to go dormant, the academic community wakes up to the frenzy of creating applications, for schools and jobs. It is an endeavour with weighty consequences, so the process is proportionately formidable – cover letters, curriculum vitae, statements of purpose, research and teaching summaries, and last but not least, letters of recommendation.

Reference letters form an integral, and occasionally decisive, part of academic applications. They can confirm and corroborate evidence of strength reflected elsewhere in the application dossier, for instance in transcripts, research publications or teaching evaluations. Their distinctive feature however lies in the “insider view” they provide of the applicant, adding a human element to a largely impersonal process. They can shed light on the merits of a research article that is still under peer-review, explain why a job candidate appears to have had a brief hiatus in research productivity, or offer clarification on why a specific term grade was not representative of an undergrad’s true academic merit. In addition to concrete information, they aim to capture intangibles, for example personal qualities not reflected in grades and transcripts, but that are often crucial in determining suitability as a colleague or adequate fit within a program or a workplace.

## L'automne, saison des lettres

**A**h, les joies de l'automne! Les feuilles qui tourbillonnent, le vent dans les arbres, les couleurs éclatantes et ... la rédaction d'une avalanche de lettres de recommandation. Alors qu'une grande partie du règne végétal et animal ralentit et se prépare à entrer en dormance, la communauté universitaire s'attelle avec frénésie à la rédaction de lettres qui accompagneront des demandes d'emploi ou d'admission à un programme d'études. Comme il s'agit d'une tâche lourde de conséquences, l'ampleur du processus est proportionnelle : lettres d'accompagnement, curriculum vitae, déclarations d'intention, résumés de recherche ou d'enseignement et, bien sûr, lettres de recommandation.

Les lettres de recommandation font partie intégrante de toute demande universitaire et jouent parfois un rôle décisif. Elles peuvent confirmer et corroborer des forces qui ressortent ailleurs dans le dossier de candidature (relevés de notes, publications de recherche, évaluations d'enseignement, etc.). Ce qui les distingue, toutefois, c'est le « point de vue de spécialiste » qu'elles présentent, ce qui ajoute un élément humain à une démarche plutôt impersonnelle. Elles peuvent faire ressortir les qualités d'un article scientifique encore à l'étude par les pairs, les raisons pour lesquelles un candidat à un poste semble avoir connu une petite baisse de productivité en recherche ou pour lesquelles une note donnée n'est pas représentative du mérite scolaire réel d'un étudiant de premier cycle. En plus de contenir de l'information concrète, elles font ressortir des éléments intangibles, par exemple les qualités personnelles qui ne paraissent pas dans les relevés de notes, mais qui sont souvent cruciales pour déterminer si une personne serait une bonne collègue ou une bonne candidate à un programme ou un emploi.

## Grading Thoughts

**Robert Dawson**, St. Mary's

CMS Notes Editor-in-Chief



### (6). Compute the following derivatives. Do not simplify...

**C**heck, they've used the chain rule correctly. *Check*, inverse trig function. *Oops*, the derivative of  $e^3$  is not  $3e^2$ . Minus one ...

Add them up. Turn to the front cover. Enter 13 out of a possible sixteen. This exam has 110 points out of a possible 100, including ten bonus marks. Put it on the heap, pick up another. *Check*, they've used the chain rule correctly...

Midterm exams – going on as I write this – and finals – as you read it – are nobody's idea of a good time. So why do we do this to ourselves? Why do we do it to our students?

We don't force it on them, of course. I've been teaching for more than a quarter of a century, and the calendar has always offered the option of auditing any course. No assignments, no exams – what could be better? Lots of things, apparently – over all those years, two people have tried auditing, and one of them didn't finish. Maybe the university doesn't publicize it well enough, but I think the reasons are deeper than that.

### (8) Find the first and second derivatives, critical points and points of inflection, and use them to sketch the graph of the following function....

*Check*, the derivative is correct. *Check*: it's factored correctly. *Check*, the intervals between the critical points are identified...

Employers want transcripts. Well, no, they don't: they probably hate them as much as we hate midterms. But they want candidates with strong skills, and transcripts tell them something about that. So the students want to be able to present transcripts to their employers. Full many a flower is born to blush unseen and find global maxima on the desert air? Not my students, and not yours. It's a matter of communication.

### (11) Jane wants to fence a field in the shape of a rectangle. One edge will run, unfenced, along the straight Arrow River. She has one thousand meters of fence material...

In the shorter term, midterms do motivate some students to study. Not all.. not that young man whose just-graded exam paper has ink on exactly two pages and a final score of one percent. And some of the top students probably didn't open their books last night. But, overall, the middle two-thirds – probably.

And putting the heavy grading on one midterm and one final lets the class concentrate on learning during the weekly recitations – and lets me give them one-minute tutorials on whatever they were stuck on without worrying about whether I was doing their work for them. So, though midterms may not be fun, they do have their uses.

... And they've used that data to plot the curve correctly. Good! Ten out of ten, last question of the last paper of the last heap.

Done.

## Réflexions sur la correction

### (6). Calculez les dérivés suivants. Ne simplifiez pas...

a règle de dérivation en chaîne est bien utilisée. *Crochet*. Fonction trigonométrique inverse. *Crochet*. *Oups*! Le dérivé de  $e^3$  n'est pas  $3e^2$ . Moins un...

J'additionne le tout. Je reviens à la première page. J'écris 13 sur une possibilité de 16. L'examen vaut 110 points sur un total possible de 100, dont 10 points bonus. Je mets l'examen sur la pile et j'en prends un autre. La règle de dérivation en chaîne est bien utilisée. *Crochet*...

Les examens de mi-session – en cours au moment où j'écris ces lignes – et les examens finals – en cours au moment où vous les lirez – ne sont des moments de réjouissance pour personne. Alors pourquoi nous imposons-nous une telle épreuve? Pourquoi l'imposons-nous à nos étudiants?

Évidemment, nous n'imposons rien. J'enseigne depuis plus d'un quart de siècle, et il a toujours été possible de suivre un cours en tant qu'auditeur. Pas de devoirs, pas d'examens... que demander de mieux? Ce n'est vraisemblablement pas la formule idéale, puisque pendant toutes ces années, deux personnes seulement se sont inscrites à mes cours comme auditrices et l'une d'entre elles n'est pas allée jusqu'au bout. Peut-être que l'université ne publie pas assez cette option, mais je pense qu'il y a des raisons plus profondes.

### (8) Trouvez la dérivée première et la dérivée seconde, les points critiques et les points d'inflexion, et utilisez-les pour tracer le graphique de la fonction suivante...

La dérivée est correcte. *Crochet*. La décomposition en facteurs est bonne. *Crochet*. Les intervalles entre les points critiques sont identifiés... *Crochet*.

Les employeurs veulent des relevés de notes. En fait, non, ils n'en veulent pas : ils les détestent probablement autant que nous détestons les examens de mi-session. Sauf qu'ils veulent des candidats ayant de solides compétences, et les relevés de notes les informer à ce sujet. Les étudiants veulent donc pouvoir présenter leurs relevés de notes à leurs employeurs. Vos étudiants, pas plus que les miens, n'ont envie de travailler dans le vide, n'est-ce pas? C'est une question de communication.

### (11) Jeanne veut clôturer un champ rectangulaire. Un côté du champ, non clôturé, bordera la rivière Arrow. Elle dispose de mille mètres de matériel pour faire sa clôture...

À plus court terme, les examens de mi-session motivent certains étudiants à étudier. Pas tous... Certainement pas ce jeune homme dont l'examen que je viens de corriger n'a que deux pages de remplies et une note finale de 1 %. Ni certains des meilleurs étudiants, qui n'ont probablement pas ouvert leurs manuels avant la veille de l'examen. Mais, dans l'ensemble, je dirais qu'ils sont une motivation pour environ les deux tiers des étudiants.

En concentrant la majorité des notes de l'année à l'examen de mi-session et à l'examen final, je permets au groupe de se concentrer sur l'apprentissage pendant les cours, ce qui me permet à moi de leur présenter des tutoriels d'une minute sur les éléments qui achoppent sans m'inquiéter de faire leur travail à leur place. Donc, si pénibles soient-ils, les examens de mi-session ont leur raison d'être.

.... Et ils ont utilisé les données pour tracer la courbe correctement. Bien! Dix sur dix, dernière question du dernier examen de la dernière pile!

J'ai fini.



## 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](mailto:notes-letters@cms.math.ca)

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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 comprimer. Les lettres acceptées paraîtront dans la langue soumise. Les lecteurs peuvent nous joindre au bureau administratif de la SMC ou à l'adresse suivante : [notes-lettres@smc.math.ca](mailto:notes-lettres@smc.math.ca).

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*Continued from cover*

What makes a strong letter of reference? This is a highly subjective matter, and the value attached to a letter can vary widely between institutions and programs. Letters bring a wealth of perspectives and insight about the person in question, which is of course what this process is all about. But the ethnic, cultural and academic diversity of the letter-writers also makes interpretation of letters a tricky business. In some parts of the world, just the act of writing a couple of lines in support of an application is considered a sign of strong endorsement – the understanding being that this is a privilege reserved for superlative candidates only. Elsewhere, and certainly in Canada, an in-depth evaluation is expected. Thus the meaning of “good” could range from stellar to passable, for the same applicant, depending on the writer and the reader.

And then there is the issue of unconscious bias – a topic widely researched and fraught with implications. Recommendation letters, not surprisingly, reflect the same gender and minority-based stereotypes that pervade all levels of applied and basic sciences. Here is a report you may want to read before reading or writing a recommendation letter: <https://www.ncwit.org/sites/default/files/resources/avoidingunintendedgenderbiaslettersrecommendation.pdf>

From a personal point of view, I prefer letters that focus on specific incidents based on the letter-writer’s professional interaction with the applicant. They speak to the depth of knowledge that the letter-writer has regarding the applicant. A detailed passionate letter stands out, providing a better understanding and appreciation for the person being evaluated. A generic letter with the boilerplate adjectives is forgettable. As I compose letters myself, I find it easier to write enthusiastically about people with whom I have had personal interactions, who have spoken to me not just about their homework and grades, but various facets of mathematics outside the curriculum, their mathematical tastes and aspirations, and their reasons for applying to a particular school, department or company. Placing the applicant in the context of a larger candidate pool, comparing them with predecessors who are currently employed at well-known institutions, is also very helpful.

As job markets and admission criteria become increasingly competitive, applicants apply to more places and request more letters in the hope of giving their applications an extra edge. Letter-writing fatigue is a common seasonal complaint at this time of year, probably second only to flu. As university faculty, we view writing letters for students and junior researchers as a regular part of our job. Frequently however, I find myself with little information to impart beyond what is present in a C.V. or a transcript. Research-based letters take on the guise of a mathematical review, with a limited glimpse of the human behind the credentials.

A note to applicants: crafting an informative letter that can genuinely improve your chances is a significant demand on the writer’s time and energy. Please choose your references carefully. If you have not had recent communication with them, evaluate whether they are still well-equipped to speak to your current strengths before approaching them for a letter. If you do, please ensure that they have the most up-to-date information about you, and know the intended audience of your applications so that they can pitch it properly. And please ask well in advance.

It is often tempting to postpone the work of lining up letter-writers. Often there are more time-critical matters to attend to. If you are an undergrad gearing up for grad school, you need to prepare for the GRE, write a statement of purpose and do extensive internet searches to make a list of prospective schools, all while keeping up with your coursework. Applicants in the academic job market are similarly overloaded. There is a thesis to be written, talks to be given and papers to be finished. Writing a reference letter is really someone else’s work, and while submitting the letter on time is important, applicants tend to view the arrangement of this task a tertiary component of the whole process. It is quite common to get letter requests a few days before a deadline. As a result, many letters we read reflect a certain ennui. In the absence of real data, important decisions are made by extrapolation on the credentials of the letter-writer and prestige of an applicant’s current institution – often putting the applicant at a disadvantage.

Now I am off to draft my n-th letter this season. Wish me luck!

## 2018 Graham Wright Award for Distinguished Service

In 1995, the Society established this award to recognize individuals who have made sustained and significant contributions to the Canadian mathematical community and, in particular, to the Canadian Mathematical Society. The award was renamed in 2008, in recognition of Graham Wright’s 30 years of service to the Society as the Executive Director and Secretary.

Nominations should include a reasonably detailed rationale and be submitted by **March 31, 2018**.

All documentation should be submitted electronically, preferably in PDF format, by the appropriate deadline, to [gaward@cms.math.ca](mailto:gaward@cms.math.ca).

## Suite de la couverture

Quelles sont les qualités d'une bonne lettre de recommandation? C'est là une question très subjective, et la valeur d'une lettre peut varier considérablement d'un établissement et d'un programme à l'autre. Une lettre de recommandation présente des perspectives de grande valeur sur la personne en question, ce qui est bien sûr le but de la démarche. Toutefois, la diversité ethnique, culturelle et scientifique de l'auteur risque également d'en compliquer l'interprétation. Dans certaines parties du monde, le simple fait de recommander une candidature en quelques lignes est considéré comme un appui de taille puisqu'il est sous-entendu qu'il s'agit d'un privilège réservé aux meilleurs candidats seulement. Ailleurs, et certainement au Canada, on s'attend à une évaluation approfondie. Ainsi, la signification de « bon » pourrait varier d'exceptionnel à passable, pour une même candidature, selon la personne qui écrit ou qui lit la lettre.

Sans parler des préconceptions inconscientes, sujet largement étudié et aux nombreuses répercussions. On ne s'étonnera pas que les lettres de recommandation reflètent les mêmes stéréotypes fondés sur le sexe et l'origine ethnique que ceux qui subsistent dans toutes les sphères des sciences appliquées et fondamentales. À ce sujet, voici un rapport que vous voudrez peut-être consulter avant de lire ou de rédiger une lettre de recommandation : <https://www.ncwit.org/sites/default/files/resources/avoidingunintendedgenderbiaslettersrecommendation.pdf>

Pour ma part, je préfère les lettres qui font ressortir des éléments basés sur les liens professionnels entre l'auteur de la lettre et le candidat. Elles montrent à quel point le rédacteur connaît bien la personne qui présente la demande. Une lettre détaillée empreinte de passion ressort du lot et permet au lecteur de mieux comprendre et d'apprécier la personne évaluée. Par contre, on risque d'oublier vite une lettre générique truffée d'adjectifs passe-partout. Quand je rédige moi-même des lettres, je trouve plus facile d'écrire avec enthousiasme sur des gens que je connais personnellement, qui m'ont parlé non seulement de leurs devoirs et de leurs notes, mais aussi de leurs activités mathématiques hors programme, de leurs goûts et aspirations mathématiques et des raisons pour lesquelles ils font une demande dans une école, un département ou une entreprise en particulier. Situer le demandeur dans le contexte d'un plus grand bassin de candidats, en le comparant à ses prédécesseurs qui travaillent à ce moment-là dans des établissements bien connus, est également très utile.

Le marché du travail étant de plus en plus concurrentiel et les critères d'admission, de plus en plus stricts, les gens multiplient les demandes – et les lettres de recommandation – dans l'espoir de bonifier leur dossier.

Après le rhume, l'épuisement lié à la rédaction de lettres de recommandation est sans doute le malaise saisonnier le plus courant à cette époque de l'année. En tant que professeurs d'université, nous considérons que produire ces lettres pour les étudiants et les jeunes chercheurs fait partie de notre travail. Bien souvent, toutefois, je me retrouve avec peu d'information pour bâtir ma lettre outre un CV et un relevé de notes. Les lettres axées sur la recherche prennent la forme d'une revue mathématique, ce qui donne un aperçu limité de la personne derrière les réalisations.

À ceux et celles qui sollicitent des lettres de recommandation, j'aimerais rappeler que la rédaction d'une lettre qui améliorera véritablement votre potentiel d'être accepté exige beaucoup de temps et d'énergie de la part du rédacteur. Il est donc important de choisir avec soin à qui vous en faites la demande.

Si vous n'avez pas été en contact avec certaines personnes récemment, demandez-vous si ces personnes sont bien placées pour décrire vos points forts avant de leur demander une recommandation. Si vous vous adressez tout de même à elles, veillez à ce qu'elles aient toute l'information nécessaire et à jour sur vous et qu'elles connaissent le public cible de la lettre pour pouvoir bien l'adapter à la situation. Et n'oubliez pas de la leur demander assez longtemps à l'avance.

Il est souvent tentant de repousser le moment de s'atteler à la rédaction de toutes ces lettres; nous avons souvent des tâches plus urgentes à mener. Si vous étudiez au premier cycle et vous apprêtez à faire des études supérieures, vous devez vous préparer aux examens d'entrée (Graduate Record Examinations), rédiger une lettre de motivation et faire des recherches poussées sur Internet pour dresser une liste d'écoles potentielles, tout en ne négligeant pas vos études en cours. Ceux qui font une demande d'emploi dans le milieu universitaire sont tout aussi occupés. Ils doivent rédiger une thèse, préparer des communications et terminer la rédaction d'articles. La rédaction de lettres de recommandation relève de quelqu'un d'autre et, bien qu'il soit important de présenter cette lettre à temps, les demandeurs ont tendance à considérer cette démarche comme un élément tertiaire du processus global. Il n'est pas rare de recevoir des demandes de lettres quelques jours avant la date limite. C'est ce qui explique que bien des lettres soient pour le moins ennuyantes. En l'absence d'information réelle, les décisions importantes sont prises par extrapolation à partir de la réputation de l'auteur de la lettre et du prestige de l'établissement fréquenté, ce qui constitue un désavantage pour le demandeur.

Je me sauve, je dois aller rédiger ma énième lettre de la saison ...  
Souhaitez-moi bonne chance!

## Prix Graham-Wright pour service méritoire 2018

**E**n 1995, la Société mathématique du Canada a créé un prix pour récompenser les personnes qui contribuent de façon importante et soutenue à la communauté mathématique canadienne et, notamment, à la SMC. Ce prix était renommé à compter de 2008 en hommage de Graham Wright pour ses 30 ans de service comme directeur administratif et secrétaire de la SMC.

Pour les mises en candidature prière de présenter des dossiers avec une argumentation convaincante et de les faire parvenir, le 31 mars 2018 au plus tard.

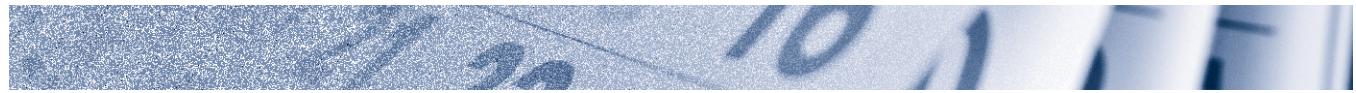
Veuillez faire parvenir tous les documents par voie électronique, de préférence en format PDF, avant la date limite à [prixgw@smc.math.ca](mailto:prixgw@smc.math.ca).

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](mailto: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](mailto:redacteur-gerant@smc.math.ca))



## DECEMBER 2017 DÉCEMBRE

- Nov 26-1** BIRS Workshop: **Partial Order in Materials: at the Triple Point of Mathematics**, Physics and Applications, BIRS, Banff, Alta.
- 3-8** BIRS Workshop: **Inferential Challenges for Large Spatio-Temporal Data Structures**, BIRS, Banff, Alta.
- 4-6** Geometry and Physics Conference (GAP 2017), The Fields Institute, Toronto, Ont.
- 4-6** Conference on Noncommutative Geometry and its Applications, Western University, London, Ont.
- 8-11** 2017 CMS Winter Meeting/Réunion d'hiver de la SMC 2017, University of Waterloo, Waterloo, Ont.
- 10-15** BIRS Workshop: **Mathematics for Developmental Biology**, BIRS, Banff, Alta.
- 11-13** CRM Workshop: **Risk Modeling, Management and Mitigation in Health Sciences**, CRM, Montreal, Que.

## JANUARY 2018 JANVIER

- 10-12** Workshop on **Connections Between Complex, Harmonic, and Stochastic Analysis**, The Fields Institute, Toronto, Ont.
- 10-13** 2018 Joint Mathematics Meetings (JMM), San Diego, Calif., USA
- 14-19** BIRS Workshop: **Interface of Machine Learning and Statistical Inference**, BIRS, Banff, Alta.
- 21-26** BIRS Workshop: **Geometry and Physics of F-theory**, BIRS, Banff, Alta.
- 26-28** The 15th Annual Combinatorial Algebra meets Algebraic Combinatorics, McMaster University, Hamilton, Ont.

## FEBRUARY 2018 FÉVRIER

- 4-9** BIRS Workshop: **Extremal Problems in Combinatorial Geometry**, BIRS, Banff, Alta.
- 11-16** BIRS Workshop: **Relativistic Fermions and Nodal Semimetals from Topology**, BIRS, Banff, Alta.
- 18-23** BIRS Workshop: **Modelling Imbalance in the Atmosphere and Ocean**, BIRS, Banff, Alta.
- 26-28** Workshop on **Pollinators and Pollination Modeling**, The Fields Institute, Toronto, Ont.

## MARCH 2018 MARS

- 5-9** Workshop on **Human-Environment Systems: Feedback and Management**, The Fields Institute, Toronto, Ont.
- 11-16** BIRS Workshop: **Modular Forms and Quantum Knot Invariants**, BIRS, Banff, Alta.
- 12-16** CRM Workshop: **Workshop in Geometric Analysis**, CRM, Montreal, Que.
- 16-18** BIRS Workshop: **Impact of Women Mathematicians on Research and Education in Mathematics**, BIRS, Banff, Alta.
- 18-23** BIRS Workshop: **New Developments in Open Dynamical Systems and Their Applications**, BIRS, Banff, Alta.
- 19-22** Workshop on **Algebraic Varieties, Hodge Theory and Motives**, The Fields Institute, Toronto, Ont.
- 25-30** BIRS Workshop: **Emerging Trends in Geometric Functional Analysis**, BIRS, Banff, Alta.

## APRIL 2018 AVRIL

- 9-13** Workshop on **Recent Progress in Nonlinear Quantum Mechanics, Theory, Simulations and Experiment**, The Fields Institute, Toronto, Ont.
- 27-29** Conference **First Year University Mathematics Across Canada: Facts, Community and Vision**, The Fields Institute, Toronto, Ont.

# FIELDS INSTITUTE DIRECTOR SEARCH

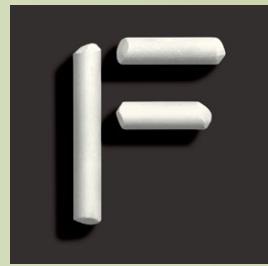
The Fields Institute for Research in Mathematical Sciences invites applications or nominations for the position of Director for a three- to five-year term (renewable once) beginning July 1, 2018 or as soon as convenient afterwards.

The Fields Institute is an independent research institute located on the St. George campus of the University of Toronto. The Institute's mission is to advance research in all areas of the mathematical sciences and to communicate the efficacy of mathematical research to the broader public. With 4000 registered annual participants from around the world, Fields programs bring together researchers and students, commercial and industrial users, and an interested public. See [www.fields.utoronto.ca](http://www.fields.utoronto.ca) for more information.

Candidates should be active researchers in the mathematical sciences with high international stature, strong interpersonal and administrative skills, and have enthusiasm and vision for the Fields Institute.

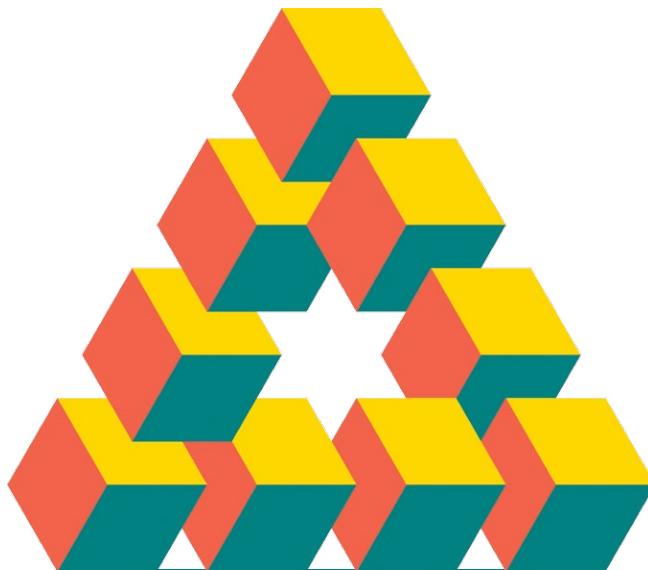
A letter of application addressing the qualities above, together with a CV and names of three references should be sent to [directorsearch@fields.utoronto.ca](mailto:directorsearch@fields.utoronto.ca). Expressions of interest or nominations are welcome and may also be sent to this address. Women and members of underrepresented groups are particularly encouraged to apply.

Applications or nominations will be considered until the position is filled, but the Search Committee plans to examine dossiers starting **January 15, 2018**.



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*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](mailto:notes-reviews@cms.math.ca))

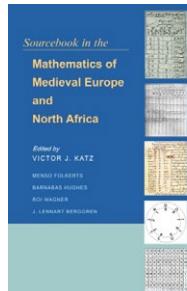
## Sourcebook in the Mathematics of Medieval Europe and North Africa

Edited by Victor J. Katz et al.

Princeton University Press, 2016

**ISBN 978-0691156859**

Reviewed by Tom Archibald, Simon Fraser University



The sourcebook as a genre had considerable popularity in the period following World War II, when the Carnegie Corporation provided a grant for the preparation of books that collected "classical papers that have shaped the structures of various sciences." These were edited, under the auspices of the AAAS and the History of Science Society, by well-known scholars, and published by Harvard University Press. No fewer than three of these had to do directly with mathematics: Dirk Struik's *Source Book in Mathematics 1200-1800*; Garrett Birkhoff's *Source Book in Classical Analysis*; and Jean van Heijenoort's *From Frege to Gödel: A Source Book in Mathematical Logic, 1879-1931*. M. R. Cohen and I. E. Drabkin's *Source Book in Greek Science* also provided a good many mathematical texts from the Greek world, and the Harvard/Heinemann Loeb Classical Library gave two volumes edited by Ivor Thomas, covering the same material in a bilingual, facing-page format. All of these works sought to bring – and brought! – these works to people who could not read the original languages, or could not easily access the original publications.

In the meantime, English has become the new Latin. Educated people around the world who read no other language beyond their mother tongue now access many products of scholarship and of international culture through the medium of English, and for works not originally produced in English, failure to be translated is a recipe for utter obscurity. With the adoption of AI strategies by Google Translate we may assume that, for many categories of work, this situation will not last long. But as in typesetting, the peculiarities of mathematics – small user group, complicated symbols, and difficult concepts – would seem to dictate that for many the necessity of printed translation done by humans will persist. This is all the more so for historical works, where commercial considerations are unlikely to drive demand.

All of which is to say that volumes like the present one, with Victor Katz as its main editor, are very welcome, and not only for giving us

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.

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access to the texts themselves in translation. The present volume, like the earlier one (likewise edited by Katz) on mathematics in Mesopotamia, Egypt, India, China, and the Islamic world, provides translations, yes, but also selects and comments succinctly on them. This work walks us through translations, chosen from previously published work or done anew by the editors, as though through the rooms of a museum of medieval cultures, choosing examples both famous and obscure that are intended to illustrate to the reader the richness and interest of those alien worlds. Indeed, like a good museum exhibit, they allow readers to immerse themselves in particular parts and reflect for themselves on the meaning, so that the commentary, initially orienting, can be set aside and the original texts and literature on them can be explored.

The volume has three main subdivisions: works from the Latin world from about 800 to almost 1500, occupying over 200 pages; mathematics in Hebrew from medieval Europe, around 150 pages; and Islamic mathematics from Medieval Spain and the Maghreb, about 170 pages. Thus while some names (Fibonacci, Levi ben Gershon, al-Khwarizmi) may be familiar, a very large number of the many authors are certain to be unknown to all but the few who make these subjects their area of specialization. The book is thus a rather wonderful introduction to the mathematics of many undeservedly obscure writers. It's also a fine repository of information about the surprising amount of relatively recent scholarship on them, which has appeared in many languages and deepened greatly the often-caricatural, impressionistic pictures of the mid-twentieth century.

The mathematical reader should approach the works ready for surprises, and they are rich in many different ways. Education systems and institutions, basic techniques, sophisticated arguments of various kinds linked with applications to positional astronomy, puzzles and games, a portion of the long struggle to grasp conceptually and notationally the relations between arithmetic (both combinatorial and number-theoretical) and geometry – all these are represented, and presented in a way that permit readers to move through at their own pace.

This is accomplished in part by a very good use of distinct fonts to distinguish clearly between translated passages and editorial reflections, and in part by moving back and forth from reflection to text in a fluid manner. Illustrations are used well as part of the texts, and help to give the flavour of the originals. Details about the sources of the works, and about secondary literature concerning them, are provided at the end of chapters, together with urls (when available) for many of the sources that may be less easy of access. The editors are expert, and the translations fluent, so that the text reads well; and if occasionally we may wonder if an editorial reflection is right to the point, in the main the commentary is spare

and the remarks helpful. This is not a review of the translations, which are in any case by many authors; this would go well beyond the reviewer's competence. But I'll comment that in translation of material of this kind, it is vexedly difficult to produce readable text that conveys the richness of cultural information embedded in the original. The texts chosen do a fine job of suggesting this richness both by their selection and by the translations they provide. Consider some examples.

Here is Martianus Capella writing in Carthage in Latin around 400 CE: " [Arithmetic is] a lady of striking appearance ... from her brow a single, scarcely perceptible whitish ray appeared." [This is the monad] "being called sacred; number coming after it and associated with it [these also appear in the text as rays] have taught that before everything the monad is the original quickener ... the dyad, because it is the first offspring, is called Genesis by some."

Such a combination of allegory and mathematical foundations is, of course, not so familiar to the modern reader. After presenting this rather wild flight of poetico-philosophical fancy, the editor remarks "thereafter follow the properties and relations of number found in elementary theories of number."

Or here is Abū 'Abd Allāh Muhammad ibn Mu'ādh al-Jayyānī, a native of Jaen (now in Spain), from the late 11th century, on ratios: "... many think that Euclid approaches the explanation of a ratio by a door other than its proper door, and introduces it in the wrong way by his definition of it by taking multiples, ... and they judge that there is no obvious connection between ratio and taking multiples. But upon my life, with nothing is ratio more closely connected than with taking multiples of the two magnitudes being compared. On the whole, I say that the fifth book [of Euclid] contains some obscurity, and that the study of it may be tiring, but all strivings are measured by the nobility of the object to be achieved, and he who aspires to a beauty's hand must pay the price ..."

This discussion speaks beautifully both of the debates about technical matters like the Eudoxan definition of ratio, in a sophisticated way, and yet manifesting values about nobility and beauty which give the lie to the image, increasingly common today among Yahoos, of Islamic culture as somehow primitive or savage.

Or lastly consider the discussion by Rabbi Simon ben Semah Duran (1361 Mallorca - 1444 Algiers) who is shown here participating in a debate concerning the value used for  $\pi$  in the Talmud. Some of his contemporaries claimed that religious authorities, in using the value 3, were aware that there were more exact approximations, but that the coarser approximation was used only when it made religious rules more strict. Ben Semah, on the other hand, noted that it sometimes was used when the resulting rules would be more lenient. The text presented takes up this question in the context of a volume measurement for a basin in the temple of Solomon, showing, as the editor puts it, the underlying concerns for the place of scientific knowledge in the interpretation of religious text and the limits of exegetic practices.

While I have emphasized, with these examples, aspects of the volume that illuminate cultural-historical issues in mathematics,

the mathematical reader need have no fear that there is a lack of detailed mathematical content of a more familiar kind. The book is filled with good problems, interesting solutions both correct and not, covering all of the mathematics that interested writers in the now-obscure period of the middle ages. The editors and their helpers have given us a rich resource as well as a project worthy of emulation for other periods and texts. Everyone interested in the origins and development of mathematical thought should spend some time with this remarkable collection.

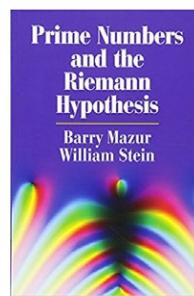
## Prime numbers and the Riemann Hypothesis

By Barry Mazur and William Stein

Cambridge University Press, 2016

**ISBN: 978-1107499430**

Reviewed by *Daniel Fiorilli*, University of Ottawa



Prime numbers are now part of our everyday life - the powerful RSA algorithm used to encrypt credit card numbers in online transactions uses large primes, and its security is based on the fact that factoring large integers is hard in general. A fundamental question which has fascinated many mathematicians is whether it is possible to understand the occurrence, or rather the distribution, of such large primes.

Already at age 15, Gauss was fascinated by tables of primes and he made a fundamental conjecture on their distribution. Comparing his guess with actual data, it is already apparent that the discrepancy is approximately the square root of the total number of primes involved, a statement which is equivalent to the Riemann Hypothesis. The revolutionary work of Riemann on the subject brought powerful tools from complex analysis in the picture, which translate "square-root error" to "zeros on the line  $Re(s) = \frac{1}{2}$ ". Indeed, he discovered that Gauss's empirical observation is directly linked with the location of the zeros of the so-called Riemann zeta function, and even more that this distribution is entirely determined by those zeros, in a fashion which is analogous to a Fourier series expansion.

The relation between prime numbers and zeros of the Riemann zeta function is one of the most beautiful and magical connections in mathematics. The idea that the set of primes can be understood with a set of harmonics, in other words that we can 'hear their music', is both surprising and powerful. The study of these harmonics, which the authors of the book call the Riemann spectrum, is the key to much of the development of our understanding of primes since Riemann's work. In particular, the Riemann Hypothesis now stands as the only open problem which is in both Hilbert's 1900 list and the 2000 Millennium Prize Problems - there is also a fair chance to see it again in the 2100 list. The particularity of this specific problem is its numerous appearances in seemingly unrelated fields and its omnipresence in number theory.

*Suite à la page 15*

*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.*

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*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.*

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*This is a time of transition for Education Notes as Jennifer Hyndman completes her eighth and final year as Co-Editor. A note of appreciation follows the opening article in this issue of Education Notes. Contributions from people in various facets of the mathematical community are welcomed. An example is featured here on the theme of computational thinking.*

## Computational Thinking: In our Undergraduate Mathematics Programs?

**Chantal Buteau**, Brock University

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**Eric Muller**, Brock University ([emuller@brocku.ca](mailto:emuller@brocku.ca))

**Laura Broley**, Concordia University

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'Computational Thinking' is becoming increasingly included in schools around the world. For example, England, France, New Zealand, and Australia have integrated it in their mandatory school education, either as a separate field of its own, as a part of mathematics courses, or transversal to curricula. Some of our provinces (e.g., British Columbia and Nova Scotia) are also following this recent trend. In fact, when reflecting on the progress of reform efforts between 2006 and 2016, computer scientist Jeanette Wing predicted that "Computational thinking will be a fundamental skill used by everyone in the world by the middle of the 21st century. By fundamental, I mean as fundamental as reading, writing, and arithmetic" (2016, p. 10). She goes on to mention the international phenomena of greater enrolment in computer science departments, and more availability of computer science courses for non-majors. But what is happening in our undergraduate mathematics programs across Canada? Should mathematics departments also adapt to this change? If so, how?

To start with, what is 'computational thinking'? Wing (2014) defines it as the thought processes involved in formulating problems and expressing their solutions in ways that enable computers (humans or machines) to effectively carry out the solving process. In other words, computational thinking is "thinking *like* a computer scientist". This does not deny the existence of an overlap with other kinds of thinking: for instance, with mathematicians' general problem solving processes, engineers' methods of designing complex systems under real-world constraints, and scientists' approaches to understanding computability, intelligence, and behaviour (Wing, 2008). It also, unavoidably, calls for a reflection on "computer programming", not as a suitable synonym,

but as a central activity to supporting the cognitive tasks involved in computational thinking (Grover & Pea, 2013, p. 40).

Suppose we leave the "should we" question for now, and begin by looking at the "how could we". Then it seems natural to start by turning our gaze upon ourselves: How do we, 'research mathematicians', integrate computational thinking in our research work? Laura Broley's (2015) master's thesis gives us some indication. Her interviews with fourteen Canadian mathematicians allowed her to document and analyze examples of how pure and applied mathematicians create and use computer programs to calculate, simulate, visualize, or experiment, whether to model phenomena, develop conjectures, or build tools for solving large classes of problems. Moreover, in 2016, mathematicians leading a six-month thematic semester on *Computational Mathematics in Emerging Applications* at the Centre de recherches mathématiques (CRM) emphasized the increasing interdependency of using computational tools and engaging in the modelling, analysis, and solving of mathematical problems in applications. A report produced five years earlier, by the European Mathematical Society, also summarized the computationally-inspired change taking place in mathematics: "*Together with theory and experimentation, a third pillar of scientific inquiry of complex systems has emerged in the form of a combination of modelling, simulation, optimization and visualization*" (2011, p. 2).

In short, when engaging in our research, we look for the most effective tool(s) to assist us in advancing our work and our thoughts, whether it is pencil and paper, or some piece of software (e.g., Maple or SAS). If the tool turns out to be digital, we may not only interact with it as an integral part of our development of mathematics (as is the case when simulating or visualizing), but we may also do some programming to alter or create a tool that is more suitable for our specific questions – this in passing answers the "should we", doesn't it? Now let's continue with "how could we".

Reflecting on our own use of computational thinking has another purpose. A recent nationwide survey (N=302) found that the use of Computer Algebra Systems in research was the most significant factor for a Canadian mathematician to integrate it in his/her teaching (Buteau et al., 2014). And a similar international study, including the USA, England, and Hungary, led to the same result (Lavicza, 2008). If we assume this holds for other digital tools, then it could be important for a mathematics department seeking to integrate

computational thinking to consider their professors' engagement in such thinking in their own research work.

But then, how could computational thinking be *integrated* in our undergraduate mathematics classrooms? In a recent work, Weintrop et al. (2016) enumerate different kinds of engagement that could be implemented in mathematics and science classrooms under the name of computational thinking. They categorize the so-called "practices" in relation to *Data, Modeling and Simulation, Computational Problem Solving, and Systems Thinking* (see Figure 1). The resulting framework is rooted in interviews the researchers conducted with scientists and mathematicians, as well as a comprehensive literature review. In Broley, Buteau, and Muller (2017), we provided further support of the framework by exemplifying each of the four categories of practices through specific mathematicians' research projects (originated from Broley's 2015 thesis) and undergraduate mathematics student assignments (originated from the Mathematics Integrated with Computers and Applications (MICA) courses at Brock University; Ben El-Mechaiekh, Buteau, & Ralph, 2007; Buteau, Muller, & Ralph, 2015).

Data Practices
Collecting data
Creating data
Manipulating data
Analyzing data
Visualizing data

Modeling & Simulation Practices
Using computational models to understand a concept
Using computational models to find and test solutions
Assessing computational models
Designing computational models
Constructing computational models

Computational Problem Solving Practices
Preparing problems for computational solutions
Programming
Choosing effective computational tools
Assessing different approaches / Solutions to a problem
Developing modular computational solutions
Creating computational abstractions
Troubleshooting and debugging

System Thinking Practices
Investigating a complex system as a whole
Understanding the relationships within a system
Thinking in levels
Communicating information about a system
Defining systems and managing complexity

Figure 1. Computational thinking practices in mathematics and science classrooms (Weintrop et al., 2016, p. 135).

The work of Weintrop et al. (2016) – Figure 1 – thus provides us with an idea of how computational thinking could be implemented in our undergraduate mathematics classrooms. Of course, the *actual* details of the implementation could vary greatly, especially when it comes to the degree to which students are asked to engage in the computational thinking themselves (Broley, Caron, & Saint-Aubin, forthcoming). It is our view that for computational thinking to be truly "integrated", we, as departments of mathematics, must also integrate it in our programs, i.e., in our departmental policies.

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## Transitioning with Education Notes

**John McLoughlin**

### Thank you Jennifer Hyndman

It was June of 2009 when I agreed to assume the editorial role with *Education Notes*. Ed Barbeau had offered his support in the transition and there were several months ahead before officially commencing in 2010. It was then that I made one of the most significant phone calls of my professional career.

Let me set the context. *Sharing Mathematics: A tribute to Jim Totten* was a conference held in Kamloops in May 2009 honouring our friend and colleague Jim Totten. The event featured several presentations and resulted with a collection of proceedings. One of the keynote presentations was by Jennifer Hyndman. The talk, *Hands-free Teaching*, subsequently appeared in the October 2009 issue of *Education Notes* (Volume 41, #6). The timing of our reconnection in Kamloops after a significant gap (since serving identical terms on the CMS Education Committee through 2001) seemed fortuitous. I decided to call Jennifer to suggest the idea of co-editing *Education Notes* for the next five years. I was delighted when Jennifer agreed to this and the two of us commenced as co-editors in January 2010 for what would become eight years. Curiously it was only months later that Jennifer Hyndman was receiving the CMS Excellence in Teaching Award at the summer meeting in Fredericton.

Jennifer is an excellent teacher and her written contributions to *Education Notes* are worth reading or revisiting for those interested in teaching. One of those contributions in October 2015 (Volume 47, #5) was entitled *Who are our teachers?* Jennifer is a dancer and her context for writing that piece grew out of an interplay of perceptions in mathematics and dance, as noted in her preface to the piece.

**As I write this article I am recovering from the second day of a five day intensive dance camp for adults. I have just experienced being a student with four different teachers covering six different styles of movement. These teachers are**

**at four different points in their careers but they all provided amazing experiences for the dancers. My development as a teacher has been strongly influenced by my experiences in the dance classroom and my growth continues to happen as I watch what the teachers do and how the students respond, and how I respond. I then translate that into how I see mathematics teaching and our students' experiences.**

The high quality of Jennifer's writing, mathematics, and teaching combined with her personable professionalism made it truly an honour to work alongside her in this role over the past eight years. Jennifer made several written contributions though she also motivated others to write for *Education Notes*. Several of these grew out of her personal connections with people in the mathematical and/or scientific communities. Others involved outreach initiatives – one of the themes explored over our eight-year tenure. On that note, I want to say, "Thank you Jennifer for your commitment and collaboration. It has truly been a pleasure working with you."

### What is ahead?

A new five-year term of the *Education Notes* will begin with the first 2018 issue. I welcome Kseniya Garaschuk aboard as the co-editor. One of the focal points of attention for *Education Notes* will be the first year experience and mathematical issues around that initial year of tertiary mathematics. Of course, contributions of articles and ideas from the community at large are welcomed on this subject or other topics.



Photo Credit : Lisa Dickson  
Drawing : Heather Grant McLoughlin

## 2018 CMS Summer Meeting

June 1 – 4, 2018

**Deadline: January 15, 2018**

University of New Brunswick, New Brunswick, Fredericton

## CALL FOR SESSIONS

The Canadian Mathematical Society (CMS) welcomes and invites session proposals for the 2018 CMS Summer Meeting in Fredericton from June 1 to 4, 2018. Proposals should include a brief description of the focus and purpose of the session, the expected number of speakers, as well as the organizer's name, complete address, telephone number, e-mail address, etc. Sessions will be advertised in the *CMS Notes*, on the web site and in the AMS Notices. Speakers will be requested to submit abstracts, which will be published on the web site and in the meeting program. Those wishing to organize a session should send a proposal to the Scientific Directors.

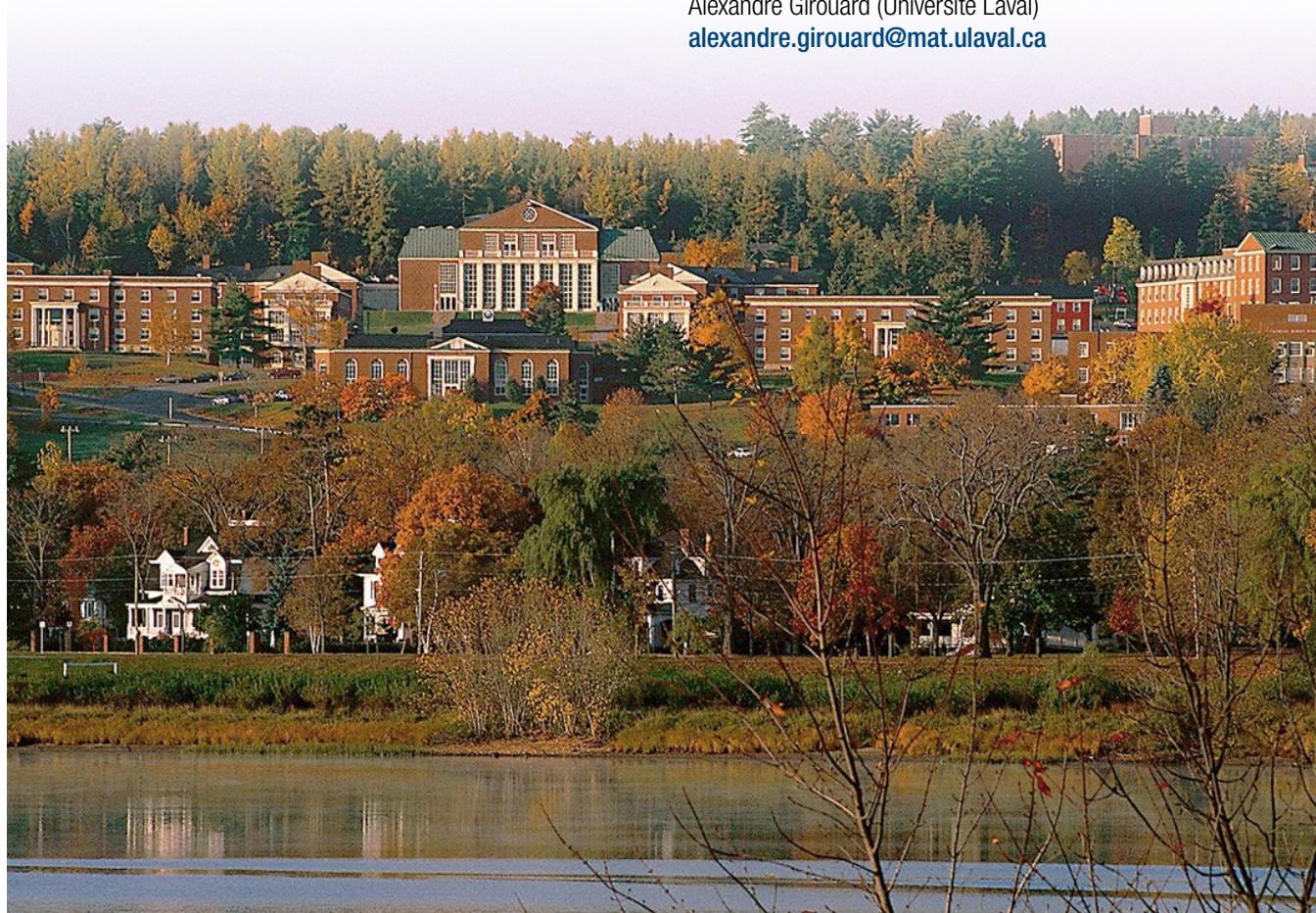
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## Réunion d'été de la SMC 2018

1 – 4 juin, 2018

**Date limite : 15 janvier 2018**

l'Université du Nouveau Brunswick, Nouveau-Brunswick, Fredericton

## APPEL DE PROPOSITIONS DE SESSIONS

La Société mathématique du Canada (SMC) vous invite à proposer des sessions pour la Réunion d'été de la SMC qui aura lieu à Fredericton du 1 au 4 juin 2018. Ces propositions doivent présenter une brève description de l'orientation et des objectifs de la session, le nombre de conférenciers prévu, de même que le nom, l'adresse complète, le numéro de téléphone et l'adresse électronique de l'organisateur. Toutes les sessions seront annoncées dans les Notes de la SMC, sur le site Web et dans les notices de l'AMS. Les conférenciers devront présenter un résumé, qui sera publié sur le site Web et dans le programme de la réunion. Toute personne qui souhaiterait organiser une session est priée de faire parvenir une proposition à un des directeurs scientifiques.

### Directeur scientifique :

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Alexandre Girouard (Université Laval)

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*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](mailto:notes-research@cms.math.ca))

## Vector valued modular forms and decompositions of vector bundles

**Cameron Franc**

**G**rothendieck [7] (building on Birkhoff [2]) showed that all holomorphic vector bundles on the complex projective line decompose uniquely into direct sums of line bundles. This result can be thought of as saying that there exists an analogue of a vector space basis for holomorphic vector bundles on the sphere. If you thus find yourself with such a bundle in your hands, it is natural to ask how it decomposes into line bundles.

This innocuous sounding question arises frequently in geometry, and it is a basic problem in the study of vector valued modular forms. For example, a positive solution to this problem would yield a dimension formula for spaces of congruence modular forms of weight one, which is a difficult yet basic problem that has been open for more than a century.

The history of vector valued modular forms dates back to Poincaré's work on Fuchsian functions and linear differential equations [9], [10]. In recent years, vector valued modular forms have played a main role in the mathematics spawned by the proof of the monstrous moonshine conjecture [3]. Indeed, these modular forms arise as generating series for characters of rational vertex operator algebras, and thus form an important part of their representation theory — see [6] for a survey.

Vector valued modular forms are multivalued sections of vector bundles on curves. When a bundle is pulled back to the complex upper half plane  $\mathcal{H}$  via a uniformisation map, its sections can be represented as single valued functions satisfying a transformation law. A basic example is the case of a flat holomorphic bundle associated to a representation  $\rho: \Gamma \rightarrow \mathrm{GL}_r(\mathbf{C})$  of some Fuchsian subgroup  $\Gamma \subseteq \mathrm{SL}_2(\mathbf{R})$ . Sections of this bundle are holomorphic functions  $F: \mathcal{H} \rightarrow \mathbf{C}^r$  satisfying the transformation law

$$F\left(\frac{a\tau + b}{c\tau + d}\right) = \rho\begin{pmatrix} a & b \\ c & d \end{pmatrix} F(\tau) \quad \text{for all } \begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma. \quad (1)$$

More generally one often incorporates an additional automorphy factor (for example, the well-known factor  $(c\tau + d)^k$ ) into (1), which at the level of vector bundles amounts to a twist by a line bundle. If the Fuchsian group  $\Gamma$  has cusps, then one typically also imposes some kind of mildness condition at the cusps (for example,

*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.*

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meromorphy or holomorphy are common conditions) — see [4] for details.

In practice one is often interested in modular forms for a specific Fuchsian group  $\Gamma$  such as the modular group  $\mathrm{SL}_2(\mathbf{Z})$ . One might imagine that this group is too simple to be of much interest — after all, its corresponding coarse moduli space  $\mathrm{SL}_2(\mathbf{Z}) \backslash \mathcal{H}$  is just the field of complex numbers! But in fact, Belyi showed in [1] that every compact algebraic curve defined by equations with algebraic numbers as coefficients can be uniformized by a subgroup of  $\mathrm{SL}_2(\mathbf{Z})$  of finite index. Optimistically one interprets this result as saying that the basic example of the modular group already contains a rich wealth of information of interest to both number theorists and geometers alike. Pessimistically, Belyi tells us that even if one is willing to focus on a single Fuchsian group such as the modular group, the geometry and group theory can be quite complicated.

Nevertheless, one can make nontrivial general statements about vector valued modular forms for the modular group. For example, if the forms are associated with a *unitary* representation of the modular group, then one has access to a vector valued form of the Rankin-Selberg method. In [11], Selberg pushed forward scalar valued forms on noncongruence subgroups to vector valued modular forms on the full modular group and used the Rankin-Selberg method to bound their Fourier coefficients. This was one of the first successful applications of vector valued forms to the study of scalar valued modular forms of more classical interest.

In joint work with Geoff Mason [5], we studied the decompositions of vector bundles giving rise to vector valued modular forms for the modular group. In order to state our results we must recall that the compactification of the moduli space of elliptic curves  $\mathrm{SL}_2(\mathbf{Z}) \backslash \mathcal{H}$  is isomorphic with the projective space  $\mathbf{P}(4, 6)$  with nonstandard weighting arising from the action  $\lambda(x, y) = (\lambda^4 x, \lambda^6 y)$  of  $\mathbf{C}^\times$  on  $\mathbf{C}^2$ . The Grothendieck-Birkhoff splitting principle holds for holomorphic vector bundles on  $\mathbf{P}(4, 6)$  [8], and line bundles on  $\mathbf{P}(4, 6)$  are isomorphic with the analogues of the usual bundles  $\mathcal{O}(k)$  on projective space. Hence, if  $\rho: \mathrm{SL}_2(\mathbf{Z}) \rightarrow \mathrm{GL}_r(\mathbf{C})$  denotes a rank  $r$  representation of the modular group, and if  $\mathcal{V}(\rho)$  denotes the corresponding flat bundle on  $\mathbf{P}(4, 6)$  (more precisely,  $\mathcal{V}(\rho)$  is an extension to the cusp of the flat bundle on  $\mathrm{SL}_2(\mathbf{Z}) \backslash \mathcal{H}$ ), then just as for  $\mathbf{P}^1$  there is a decomposition

$$\mathcal{V}(\rho) \cong \bigoplus_{k \in \mathbb{Z}} m_k \mathcal{O}(k) \quad (2)$$

for uniquely determined integers  $m_k \geq 0$  giving a partition of the rank,  $\sum_{k \in \mathbf{Z}} m_k = r$ . These integers  $m_k$  can be difficult to compute: for example if  $\rho$  is a unitary representation, then  $m_{-1}$  is the dimension of the space of modular forms of weight one associated with  $\rho$ , a notoriously difficult quantity to compute in general. In the nonunitary case the situation is even worse. Setting our sights lower than obtaining general formulae for these multiplicities, in [5] we proved the following:

**Theorem 1.** Suppose that  $\mathrm{SL}_2(\mathbf{Z}) \rightarrow \mathrm{GL}_r(\mathbf{C})$  is irreducible and let  $m_k$  denote the multiplicities in the decomposition (2). Then the following hold:

- (a) no-gap lemma: if  $m_{k-2} \neq 0$  and  $m_{k+2} \neq 0$  then  $m_k \neq 0$ ;
- (b) three-term inequality: if  $\rho$  is further assumed to be unitary, then the inequality  $m_k \leq m_{k-2} + m_{k+2}$  holds for all integers  $k$ .

Note that in the irreducible case, all indices  $k$  for which  $m_k \neq 0$  must have the same parity. The proof of Theorem 1 in [5] uses properties of a modular differential operator that acts on sections of the bundle  $\mathcal{V}(\rho)$ . Computations outlined in [5] suggest that part (b) of Theorem 1 should hold without the hypothesis that  $\rho$  is unitary, although the nonunitary case remains open.

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### Prime numbers and the Riemann Hypothesis, continued from page 9

Given its fundamental importance in mathematics, we need to convey this importance to as many people as possible, and in particular in an accessible way that requires the least amount of mathematical background. Mazur and Stein took up this task and succeeded in a remarkable way. Their efforts resulted in an impressively accessible and yet very up-to-date account of the field, written in a language that can appeal to anybody interested in mathematics, even without much formal background. The book is divided into four parts, and the first part, which constitutes half of the book and contains much of the ideas, is accessible with only high-school math. The remaining parts of the book go more deeply into the so-called Riemann spectrum and are accessible with first-year calculus. The reviewer was very impressed with the expository innovations of the book. Noteworthy are the analogy between Cesàro smoothing and average car speed, a very down-to-earth introduction to distributions, and also links between spectrum and MP3 compression, and so on.

The first part of the book starts with a historical introduction to prime number theory, surveying many important and interesting questions that have arisen over the last centuries. The authors then move on to more specific questions about the distribution of primes, chiefly the study of  $\pi(x)$ , the number of primes up to  $x$ . They explain what the Riemann Hypothesis implies about this function, and give hints on how it can be expanded in a generalized Fourier series.

The second part of the book focuses on Fourier transforms and distributions. This advanced subject is broken down in an extremely accessible description which is sufficient for the purposes of the book but which also gives the reader an intuitive understanding of this important theory.

The third part concentrates on the Riemann spectrum, more particularly its distribution. The authors introduce the reader to central questions in analytic number theory such as the number of harmonics in a given window as well as their spacing statistics. Readers interested in these questions will quickly move on to a very active field of research and its links with random matrix theory.

The final part of the book goes back to the prime-counting function  $\pi(x)$ , explaining precisely how it relates to the Riemann spectrum. The authors also introduce the Riemann zeta-function and its generalizations.

In summary, this book is an accessible account of the vast and exciting theory of prime numbers and will certainly inspire many students to pursue graduate studies and make original contributions to the field. It is recommendable to anybody interested in primes, from world experts to amateurs and students of all levels.

# Nonlinear Elliptic PDEs: Applications and Computation

**Adam M. Oberman**, *McGill University*

**C**lassical PDEs often arise from physical principles. Often the independent variables represent spatial coordinates, in one, two or three dimensions. In this note we discuss a modern class of Partial Differential Equations (PDEs), degenerate elliptic PDEs in the sense of [CIL92], which has found applications in a wide range of non-physical applications.

In applications, the variables can represent, for example, pixels (in the case of image processing), the coordinates of a manifold (in the case of curvature flows), or the monetary value of a portfolio of assets (in the case of math finance). Applications include (in roughly chronological order)

- (1) The Level Set Method [Set99, OF03] for evolving hypersurfaces according to normal velocity, including curvature based motions [Cig06].
- (2) Mathematical Image Processing [Sap06].
- (3) Deterministic and Stochastic Optimal Control Theory [FR12], differential pursuit-evasion games [Ils99].
- (4) Homogenization [ES08]: replacing a fine scale spatially dependent PDE with a spatially independent (homogeneous) one, in the limit.
- (5) Mathematical Finance [KS98]: Black-Scholes formula, pricing exotic options, Merton's portfolio problem. Two Nobel Prizes in economics were awarded in this area, which peaked in the 90's and 2000's. .
- (6) Monge-Ampère PDEs and Optimal Transportation [Vil03].
- (7) Probabilistic game interpretation of PDEs [PSSW11, KS06].
- (8) Machine Learning: sorting vector data [CEH15], regularization and improved training of Deep Neural Networks in high dimensions [COO+17].

Viscosity Solutions<sup>1</sup>, in the sense of [CIL92], applies to the class of scalar, degenerate elliptic equations (which also includes parabolic equations). Classical solutions of the PDE are twice continuously differentiable: weak solutions are only semi-continuous. Weak solutions are needed, because it is often the case that solutions are singular. For example, the distance function to a set is the solution of a nonlinear PDE in this case, and distance functions have singularities (corners) at locations where there are multiple closest points. More generally control problems have singularities where there are multiple optimal controls. Instead of defining weak solutions using integration by parts, (or by taking the zero viscosity

limit), viscosity solutions are defined by touching from above or below by a smooth function, and requiring that the PDE hold with a corresponding inequality. The fundamental mathematical question is well-posedness: existence, uniqueness, stability of weak solutions. The definition is enough to establish well-posedness for a wide class of equations. The theory, while technical in its details, has an appealing geometrical flavour, with connection to Convex Analysis [BNO+03]. Under additional conditions (for example uniform ellipticity) regularity results, meaning that weak solutions are classical are available [CC95]. There are by now some very accessible resources for learning this material. Refer to as [Eva98, Chapter 10] and [Cal16].

**Extensions.** There are two major recent areas which can be regarded as generalizations of the theory. (i) nonlinear nonlocal PDEs such as the fractional Laplacian [CS07]. Here the theory is generalized from (local) PDEs, to nonlocal operators, while keeping many properties of solutions (for example the Comparison Principle, and regularity theory). (ii) Mean Field Games [LL07], which is a generalization of Stochastic Optimal Control, to include a population of agents who interact with each other only through the statistics of the density (in other words, they are all small players, playing against the mean). These areas are lead by L. Caffarelli and P.L. Lions, respectively, both of whom had major roles in the establishment of viscosity solutions theory.

**Computing solutions.** Applications require the solution, at least in approximate form. Most often, this means computing approximate solutions. Numerical methods for nonlinear PDEs were developed in earnest in the 1980's beginning with conservation laws (see [LeV92]), and followed afterwards by numerical methods for Viscosity Solutions, with the highly cited paper on the Level Set Method [OS88]. Early numerical methods exploited the connection (via  $v = u_x$ ) between viscosity solutions of the Hamilton-Jacobi equation,  $u_t = u_x^2$ , and entropy solutions of Burger's equations,  $v_t = vv_x$ . The convergence theory for numerical methods [BS91] is based on the stability of viscosity solutions. Elliptic finite difference schemes satisfy a discrete comparison principle [Obe96] and converge provided they are consistent.

A major challenge is to solve these PDEs in high dimensions, where the curse of dimensionality appears to prohibit general solvers. In other fields, additional structure has allows for solving high dimensional problems in special but important cases. For example, Markov Chain Monte Carlo (MCMC) methods allow for density estimation (computation of integrals) in high dimensions, and compressed sensing allows us to find sparse solutions of linear equations in high dimensions.

<sup>1</sup> The nomenclature "Viscosity Solutions" comes from idea of regularization by adding small multiple of the Laplacian to a PDE. This technique can be applied in more general settings for example, the Navier-Stokes is the Euler equation with viscosity added. The term viscosity solutions is also used in these contexts.

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*CSHPM Notes brings scholarly work on the history and philosophy of mathematics to the broader mathematics community. Authors are members of the Canadian Society for History and Philosophy of Mathematics (CSHPM). Comments and suggestions are welcome; they may be directed to either of the column's co-editors:*

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## ORESME turns 20: how a reading group in the history of mathematics thrives

**Dan Curtin**, Northern Kentucky University

**Danny Otero**, Xavier University

The history-of-mathematics seminar known as the ORESME (Ohio River Early Sources in Mathematical Exposition) Reading Group was formed in 1998 to read original source material in mathematics from a variety of different eras. ORESME meets twice a year, usually in late September at Xavier University (Cincinnati, OH) and again in late January at Northern Kentucky University (Highland Heights, KY); the two universities are no more than 10 miles apart, and this way we (Danny and Dan) share the hosting duties.

ARITHMOS is another reading group seminar of primary historical texts in mathematics, which meets in southwestern New England at Western Connecticut State University (see [home.adelphi.edu/~bradley/Arithmos/](http://home.adelphi.edu/~bradley/Arithmos/)). ARITHMOS was begun a few years before ORESME, by Rob Bradley (Adelphi University) and Ed Sandifer (Western Connecticut State University), who, like us, were alumni of the highly influential Institute on the History of Mathematics and Its Use in Teaching (IHMT), run in the mid-1990s by V. Fred Rickey, Victor J. Katz and Steven Schot at American University in Washington, DC. The IHMT, a multi-year program for teachers of undergraduate mathematics (and in some cases, even of secondary mathematics) to help them learn the history of mathematics and, yes, its use in teaching, held regular sessions at which participants tackled readings of primary historical sources. It was the powerful impact of these group reading experiences that led to the organization of ARITHMOS and of ORESME, with the aim of recreating these experiences with ongoing regularity for other participants, in two different regions of the United States.

Typically, ORESME meetings attract between 8 and 16 participants, most of whom are regulars. Nearly all are mathematicians at area universities and colleges (although one is a computer scientist); some are retired. Occasionally a graduate student has also participated. Most live in the Greater Cincinnati area, but we also welcome attendees who willingly drive hours to join in; likewise, we regularly recruit newcomers.

*Les articles de la SCHPM présentent 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:*

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

At each ORESME meeting we typically choose a source (or two or three, depending on their length and our ambitions) written by a figure of note in the history of mathematics. The selected sources are made available ahead of time in English translation; we much prefer texts already available in English, of course, but we also often work hard to make translations of texts if they not readily available elsewhere. It is rare that anyone in the group is an expert in the topic at hand, but (somewhat to our surprise at first) our pooled ignorance usually leads to good understanding.

We always start on a Friday evening, sharing a meal at a local restaurant. After the meal, at around 8:00 pm, we reconvene in a university seminar room and begin our discussions by briefly considering biographical details of the author of the works we are reading. Then we embark on a careful reading of the material, trying to understand what the author was trying to do and what influences we can detect by reading between the lines of the text. Inevitably, some of us prepare by consulting the secondary literature on the source, and this also helps to illuminate the author's purpose. We work on the readings for about two hours, then end the evening with light refreshments, beverages and conversation. We meet again the next morning at around 9:30 for orange juice, bagels and coffee, and return to our discussion by 10:00 with a second session that lasts until noon. Our meetings end with a discussion of what we might tackle next; final decisions in that regard are usually made later, via email.

For example, at our first meeting, January 30–31, 1998, at Xavier, we read William Fogg Osgood's paper, "A Jordan Curve of Positive Area" (*Trans. AMS*, 4 (1903): 107–112). This proved to be just challenging enough to stretch our abilities, yet interesting enough to easily fill the time. Perhaps our least successful use of a source was our attempt in two consecutive meetings in 1999 to deal with Felix Klein's *Erlangerprogramm*. It turned out to be unproductive to actually read Klein, but we managed to have fruitful discussions on the topic by working from secondary sources. We also were able to inject some humour into the proceedings by meeting for dinner in a pub in nearby Erlanger, KY.

On two occasions we took advantage of visiting scholars to soup up our discussions. We visited Miami University in 2000, where the late John Fauvel aided our discussion of Newton's *De analysi* (1669), and in 2002 we travelled to the University of Louisville (pronounced "Luhvll"), where Michael J. Crowe led our discussion of the work of

Hermann Grassman (1809–1877) and, more generally, the history of vector analysis.

The most recent meeting of ORESME was very special: it was held jointly with the Midwest History of Mathematics Conference at Wabash College in Crawfordsville, IN, on September 29–30, 2017, where we celebrated the 20th anniversary of ORESME. At the MHMC meeting, we recruited all the attendees to participate in ORESME's reading of two selections from the works of Jean le Rond d'Alembert (1717–1783), in commemoration of the tercentennial of his birth. The opening keynote address at the MHMC, on the mathematical career of d'Alembert, was delivered by Rob Bradley, after which we held a three-hour session to read two papers of d'Alembert. The first, on the vibrating string, was the earliest in which PDEs were used to model the underlying physical phenomenon. In the second, on convergence and divergence of series, d'Alembert stated the ratio test for the first time and examined series that converge or diverge "only in their later terms."

We believe that all our members who take part in these reading sessions learn thereby a good deal of history of mathematics—and they learn a fair amount of mathematics, too. Our discussions are mathematically serious, but always take place with a good deal of humour mixed in. Our informal style of proceeding makes it easy to sense the enjoyment we derive from getting together to understand important mathematical texts.

We are convinced that other interested groups could easily follow a similar plan to ours, fitting a meeting schedule to local needs. Our website, [www.nku.edu/~curtin/oresme.html](http://www.nku.edu/~curtin/oresme.html), lists all the readings we have done over the years. We would be delighted to consult with anyone interested in such an undertaking—and, even better, you could learn from our mistakes! Those wishing to try out a history-of-mathematics reading group are welcome to visit ORESME; just email either Dan or Danny for details.

*Dan Curtin (curtin@nku.edu) retired this summer as Professor Emeritus, after 38 years at Northern Kentucky University. He is continuing his work in the history of mathematics, when he is not trying to keep up with his three granddaughters or playing Irish music in some pub. Danny Otero (otero@xavier.edu) is an Associate Professor of mathematics at Xavier University in Cincinnati, Ohio. He is currently a Principal Investigator on the NSF-sponsored TRIUMPHS (TRansforming Instruction in Undergraduate Mathematics via Primary Historical Sources) grant team. He runs a weekly Bible study and enjoys playing bridge, listening to music, reading to his wife, and getting to know his three grandchildren.*



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

À près de 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'AARMS, le CANSSI, la SRIB, l'Institut Périmètre, l'Université de Montréal et l'UQAM.

<https://icmp2018.org/fr/inscription>

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

À fter 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/registration>

## 2018 Doctoral Prize

The CMS Doctoral Prize recognizes outstanding performance by a doctoral student. The prize is awarded to one or two recipients of a Ph.D. from a Canadian university whose overall performance in graduate school is judged to be the most outstanding. Although the dissertation will be the most important criterion (the impact of the results, the creativity of the work, the quality of exposition, etc.) it will not be the only one. Other publications, activities in support of students and other accomplishments will also be considered.

Nominations that were not successful in the first competition will be kept active for a further year (with no possibility of updating the file) and will be considered by the Doctoral Prize Selection Committee in the following year's competition.

The CMS Doctoral Prize will consist of an award of \$500, a two-year complimentary membership in the CMS, a framed Doctoral Prize certificate and a stipend for travel expenses to attend the CMS meeting to receive the award and present a plenary lecture.

### Nominations

Candidates must be nominated by their university and the nominator is responsible for preparing the documentation described below, and submitting the nomination to the address below. No university may nominate more than one candidate and the deadline for the receipt of nominations is **January 31, 2018**.

The documentation shall consist of:

- A curriculum vitae prepared by the student.
- A resumé of the student's work written by the student and which must not exceed ten pages. The resumé should include a brief description of the thesis and why it is important, as well as of any other contributions made by the student while a doctoral student.
- Three letters of recommendation of which one should be from the thesis advisor and one from an external reviewer. A copy of the external examiner's report may be substituted for the latter. More than three letters of recommendation are not accepted.

All documentation, including letters of recommendation, should be submitted electronically, preferably in PDF format, by the appropriate deadline, to [docprize@cms.math.ca](mailto:docprize@cms.math.ca).

## Prix de doctorat 2018

La SMC a créé ce **Prix de doctorat** pour récompenser le travail exceptionnel d'un étudiant au doctorat. Le prix sera décerné à une personne qui aura reçu son diplôme de troisième cycle d'une université canadienne l'année précédente (entre le 1er janvier et le 31 décembre) et dont les résultats pour l'ensemble des études supérieures seront jugés les meilleurs. La dissertation constituera le principal critère de sélection (impact des résultats, créativité, qualité de l'exposition, etc.), mais ne sera pas le seul aspect évalué. On tiendra également compte des publications de l'étudiant, de son engagement dans la vie étudiante et de ses autres réalisations.

Les mises en candidature qui ne seront pas choisies dans leur première compétition seront considérées pour une année additionnelle (sans possibilité de mise à jour du dossier), et seront révisées par le comité de sélection du Prix de doctorat l'an prochain.

Le lauréat du Prix de doctorat de la SMC aura droit à une bourse de 500 \$. De plus, la SMC lui offrira l'adhésion gratuite à la Société pendant deux ans et lui remettra un certificat encadré et une subvention pour frais de déplacements lui permettant d'assister à la réunion de la SMC où il recevra son prix et présentera une conférence.

### Candidatures

Les candidats doivent être nommés par leur université; la personne qui propose un candidat doit se charger de regrouper les documents décrits aux paragraphes suivants et de faire parvenir la candidature à l'adresse ci-dessous. Aucune université ne peut nommer plus d'un candidat. Les candidatures doivent parvenir à la SMC au plus tard le **31 janvier 2018**.

Le dossier sera constitué des documents suivants :

- Un curriculum vitae rédigé par l'étudiant.
- Un résumé du travail du candidat d'au plus dix pages, rédigé par l'étudiant, où celui-ci décrira brièvement sa thèse et en expliquera l'importance, et énumérera toutes ses autres réalisations pendant ses études de doctorat.
- Trois lettres de recommandation, dont une du directeur de thèse et une d'un examinateur de l'extérieur (une copie de son rapport serait aussi acceptable). Le comité n'acceptera pas plus de trois lettres de recommandation.

Veuillez faire parvenir tous les documents par voie électronique, de préférence en format PDF, avant la date limite à [prixdoc@smc.math.ca](mailto:prixdoc@smc.math.ca).

## 2018 Adrien Pouliot Award

Nominations of individuals or teams of individuals who have made significant and sustained contributions to mathematics education in Canada are solicited. Such contributions are to be interpreted in the broadest possible sense and might include: community outreach programs, the development of a new program in either an academic or industrial setting, publicizing mathematics so as to make mathematics accessible to the general public, developing mathematics displays, establishing and supporting mathematics conferences and competitions for students, etc.

Nominations must be received by the CMS Office **no later than April 30, 2018**.

Please submit your nomination electronically, preferably in PDF format, to [apaward@cms.math.ca](mailto:apaward@cms.math.ca).

### Nomination requirements

- Include contact information for both nominee and nominator.
- Describe the nominated individual's or team's sustained contributions to mathematics education. This description should provide some indication of the time period over which these activities have been undertaken and some evidence of the success of these contributions. This information must not exceed four pages.
- Two letters of support from individuals other than the nominator should be included with the nomination.
- Curricula vitae should not be submitted since the information from them relevant to contributions to mathematics education should be included in the nomination form and the other documents mentioned above.
- If nomination was made in the previous year, please indicate this.
- Members of the CMS Education Committee will not be considered for the award during their tenure on the committee.

### Renewals

Individuals who made a nomination last year can renew this nomination by simply indicating their wish to do so by the deadline date. In this case, only updating materials need be provided as the original has been retained.

## Prix Adrien Pouliot 2018

Nous sollicitons la candidature de personne ou de groupe de personnes ayant contribué d'une façon importante et soutenue à des activités mathématiques éducatives au Canada. Le terme « contributions » s'emploie ici au sens large; les candidats pourront être associés à une activité de sensibilisation, un nouveau programme adapté au milieu scolaire ou à l'industrie, des activités promotionnelles de vulgarisation des mathématiques, des initiatives spéciales, des conférences ou des concours à l'intention des étudiants, etc.

Les mises en candidature doivent parvenir au bureau de la SMC **avant le 30 avril 2018**.

Veuillez faire parvenir votre mise en candidature par voie électronique, de préférence en format PDF, à [prixap@smc.math.ca](mailto:prixap@smc.math.ca).

### Conditions de candidature

- Inclure les coordonnées du/des candidat(s) ainsi que du/des présentateur(s).
- Décrire en quoi la personne ou le groupe mis en candidature a contribué de façon soutenue à des activités mathématiques. Donner un aperçu de la période couverte par les activités visées et du succès obtenu. La description ne doit pas être supérieure à quatre pages.
- Le dossier de candidature comportera deux lettres d'appui signées par des personnes autres que le présentateur.
- Il est inutile d'inclure des curriculums vitae, car les renseignements qui s'y trouvent et qui se rapportent aux activités éducatives visées devraient figurer sur le formulaire de mise en candidature et dans les autres documents énumérés ci-dessus.
- Si la candidature a été soumise l'année précédente, veuillez l'indiquer.
- Les membres du Comité d'éducation de la SMC ne pourront être mis en candidature pour l'obtention d'un prix pendant la durée de leur mandat au Comité.

### Renouveler une mise en candidature

Il est possible de renouveler une mise en candidature présentée l'année précédente, pourvu que l'on en manifeste le désir avant la date limite. Dans ce cas, le présentateur n'a qu'à soumettre des documents de mise à jour puisque le dossier original a été conservé.



**December 8-11, 2017**

University of Waterloo – Waterloo, Ontario  
[cms.math.ca/Events/winter17](http://cms.math.ca/Events/winter17)

### Prizes | Prix

**2017 Excellence in Teaching Award | Prix**

**d'excellence en enseignement**

Bernard Hodgson (Laval)

**2017 Adrien Pouliot Award | Prix Adrien-Pouliot**

Richard Hoshino (Quest)

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

Sabin Cautis (UBC)

**2017 Doctoral Prize | Prix de doctorat**

Konstantin Tikhomirov (Princeton)

**2017 Graham Wright Award for Distinguished Service |**

**Prix Graham Wright pour service méritoire**

Joseph Khoury (Ottawa)

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

Alan Beardon (formerly Cambridge)

### 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](http://cms.math.ca/Reunions/hiver17)

### Plenary Lectures | Conférences plénierées

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

### Supported by | Soutenu par





## 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: 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 and Jerry Wang (University of Waterloo)

### 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)

## Graham Wright Award for Distinguished Service / Prix Graham Wright pour service méritoire

**Joseph Khoury** (*Ottawa*)



**J**oseph Khoury's contributions to the greater mathematical community are equally diverse, ranging from committee service, to writing books that attract readers to mathematics, to developing successful and sustained outreach activities at many levels, focused on improving the general community's perception of Mathematics and Mathematics Education. Dr. Khoury is "the kind of individual who sees what needs to be done – or what can be done – and finds a way to make it happen".

Les contributions de Joseph Khoury à la grande communauté mathématique sont également diversifiées, allant du service au sein de divers comités, à la rédaction des livres qui attirent les lecteurs à la beauté des mathématiques, au développement des diverses activités communautaires réussies et soutenues à plusieurs niveaux et qui sont axées sur la perception générale des mathématiques et l'éducation des mathématiques. Joseph est "une personne qui peut voir ce qui doit être accompli - ou ce qui peut être accompli - et trouve un moyen pour l'accomplir.

## Adrien Pouliot Award / Prix Adrien Pouliot

**Richard Hoshino** (*Quest*)



**R**ichard Hoshino has published 28 research papers across numerous fields, including graph theory, marine container risk-scoring, biometric identification, and sports scheduling. He has consulted for the billion-dollar professional baseball league in Japan, as well as three Canadian TV game shows (Qubit, Splatalot, and Spin-Off).

Richard Hoshino a publié 28 articles scientifiques dans de nombreux domaines, dont la théorie des graphes, la cotation des risques pour les conteneurs maritimes, l'identification biométrique et la planification sportive. Il a été consultant pour la multimilliardaire ligue de baseball professionnelle du Japon et pour trois jeux télévisés canadiens (Qubit, Splatalot et Spin-Off).

## Excellence in Teaching Award / Prix d'excellence en enseignement

**Bernard Hodgson** (*Laval*)



**H**odgson's students write in glowing terms of his enthusiasm and passion for mathematics, about his skill in communicating ideas, his attentiveness to students, and his ability to motivate them. It is clear from testimony that Hodgson's teaching has had a lasting influence in the lives of many students who have taken a course from him.

Les étudiants du professeur Hodgson décrivent en termes élogieux son enthousiasme et sa passion pour les mathématiques, son aptitude à communiquer les idées, son attention envers les étudiants et sa capacité de les motiver. Il ressort clairement de leurs témoignages que le professeur Hodgson a eu une grande influence sur la vie de nombreux étudiants qui ont suivi ses cours.

## G. de B. Robinson Award / Prix G. de B. Robinson

**Alan Beardon** (*formerly Cambridge*)



**A**lan Beardon's paper deals with groups of real isometries which map the real number line to itself, with a particular focus on studying the conjugacy classes of the groups whose discrete forms correspond to the seven classic frieze groups. The results of this paper (written in an effective way to make itself more accessible to the reader) will be of interest to a wide audience.

L'article de Beardon traite les groupes d'isométries réelles qui transforment la droite réelle en elle-même, en mettant l'accent sur l'étude des classes de conjugaison des groupes dont les formes discrètes correspondent aux sept groupes de frise classiques. Les résultats de cet article (écrit de façon efficace pour qu'il soit plus accessible au lecteur) seront d'un intérêt pour une large audience.

## Coxeter-James Prize / Prix Coxeter-James

**Sabin Cautis** (*UBC*)



**P**rof. Cautis is a leader in the new and rapidly developing field of categorification as it relates to geometric representation theory, algebraic geometry, mathematical physics and low-dimensional topology. Categorification is a search for deeper structure behind invariants in algebra and topology.

Le professeur Cautis est un chef de file de la catégorification, un domaine nouveau et en croissance rapide qui se situe au carrefour de la théorie géométrique des représentations, de la géométrie algébrique, de la physique mathématique et de la topologie en basses dimensions. La catégorification est la recherche d'une structure plus profonde derrière les invariants en algèbre et en topologie.

## Doctoral Prize / Prix de doctorat

**Konstantin Tikhomirov** (*Princeton*)



In his doctoral studies, Tikhomirov investigates on a series of open problems in diverse areas of mathematics. He has written at least ten papers related to Asymptotic Geometric Analysis, Random Matrices, Probability Theory, and Convex Geometry. In particular, he worked on the problem of estimating the distance between an  $n$ -dimensional polytope with a fixed number of vertices and the Euclidian ball. In this case he solved the exact dependence between the dimension and the number of vertices.

Konstantin Tikhomirov a fait ses études de doctorat sur une série de problèmes ouverts dans divers domaines des mathématiques. Il a rédigé au moins dix articles sur l'analyse géométrique asymptotique, les matrices aléatoires, la théorie des probabilités et la géométrie convexe. En particulier, il a travaillé sur la question de l'estimation de la distance entre un polytope de dimension  $n$  ayant un nombre fixe de sommets et le boule euclidien. Dans ce cas, il a résolu la question de la dépendance exacte entre la dimension et le nombre de sommets.

## Jeffery-Williams Prize / Prix Jeffery-Williams

**Robert McCann** (*Toronto*)



**M**cCann is an internationally recognized expert in applied mathematics at the forefront of the development of the theory and applications of optimal transportation. Together with his collaborators and peers worldwide, he has led a renaissance in the theory of optimal transportation, helping to transform it into one of the most vibrant and exciting areas in mathematics today.

Robert McCann est un expert de renommée mondiale des mathématiques appliquées, précurseur de la théorie du transport optimal et de ses applications. Avec ses collaborateurs et collègues du monde entier, il a engendré une véritable renaissance de la théorie du transport optimal, qui a contribué à faire de ce domaine l'un des plus dynamiques et passionnantes des mathématiques en ce moment.

## Krieger-Nelson Prize / Prix Krieger-Nelson

**Stephanie van Willigenburg** (*UBC*)



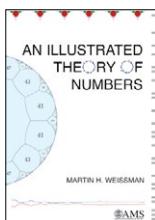
**P**rof. van Willigenburg is a leading expert in algebraic combinatorics, a vibrant area of mathematics that connects with many other fields of study including representation theory, algebraic geometry, mathematical physics, topology and probability. Her research and subsequent discoveries have focused on Schur functions, skew Schur functions and quasisymmetric Schur functions, central topics within the field of algebraic combinatorics.

Madame van Willigenburg est une experte de premier plan de la combinatoire algébrique, un domaine dynamique des mathématiques qui a des liens avec de nombreux autres domaines d'études, y compris la théorie représentationnelle, la géométrie algébrique, la physique mathématique, la topologie et la probabilité. Ses recherches et ses découvertes ultérieures ont porté sur les fonctions de Schur, les fonctions de Schur gauches et les fonctions de Schur quasi symétriques, qui sont des thèmes centraux dans le domaine de la combinatoire algébrique.

# AMERICAN MATHEMATICAL SOCIETY

## NEW BOOKS

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### An Illustrated Theory of Numbers

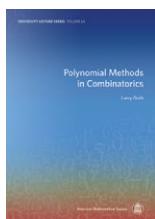
Martin H. Weissman, *University of California, Santa Cruz, CA*

*An Illustrated Theory of Numbers is a textbook like none other I know; and not just a textbook, but a work of practical art. This book would be a delight to use in the undergraduate classroom, to give to a high school student in search of enlightenment, or to have on your coffee table, to give guests from the world outside mathematics a visceral and visual sense of the beauty of our subject.*

—Jordan Ellenberg, *University of Wisconsin-Madison, author of How Not to Be Wrong: The Power of Mathematical Thinking*

This comprehensive introduction to number theory, with complete proofs, worked examples, and exercises, reflects the most recent scholarship in mathematics and its history and includes historical notes that curate primary sources and secondary scholarship to trace the development of number theory within and outside the Western tradition.

2017; 323 pages; Hardcover; ISBN: 978-1-4704-3493-9; List US\$69; AMS members US\$55.20; Order code MBK/105



### Polynomial Methods in Combinatorics

Larry Guth, *Massachusetts Institute of Technology, Cambridge, MA*

*In the 273 page long book, a huge number of concepts are presented, and many results concerning them are formulated and proved. The book is a perfect presentation of the theme.*

—Béla Uhrin, *Mathematical Reviews*

The book contains approximately 100 exercises that further the reader's understanding of the main themes of the book.

**University Lecture Series**, Volume 64; 2016; 273 pages; Softcover; ISBN: 978-1-4704-2890-7; List US\$48; AMS members US\$38.40; Order code ULECT/64

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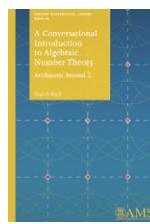
### Alice and Bob Meet Banach

*The Interface of Asymptotic Geometric Analysis and Quantum Information Theory*

Guillaume Aubrun, *Université Claude Bernard Lyon 1, Villeurbanne, France*, and Stanisław J. Szarek, *Case Western Reserve University, Cleveland, OH*, and Sorbonne Université, Paris, France

By building a bridge between two distinct but intensively interacting fields, asymptotic geometric analysis and quantum information theory, this book presents deep insights into the behavior of entanglement and related phenomena in a high-dimensional setting.

**Mathematical Surveys and Monographs**, Volume 223; 2017; 414 pages; Hardcover; ISBN: 978-1-4704-3468-7; List US\$116; AMS members US\$92.80; Order code SURV/223



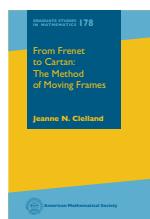
### A Conversational Introduction to Algebraic Number Theory

Arithmetic Beyond  $\mathbb{Z}$

Paul Pollack, *University of Georgia, Athens, GA*

Written in a conversational style, this introduction to algebraic number theory lays out the three classical “fundamental theorems”: unique factorization of ideals, finiteness of the class number, and Dirichlet’s unit theorem, while also frequently alluding to recent developments within the field.

**Student Mathematical Library**, Volume 84; 2017; 312 pages; Softcover; ISBN: 978-1-4704-3653-7; List US\$52; AMS members US\$41.60; Order code STML/84



### From Frenet to Cartan: The Method of Moving Frames

Jeanne N. Clelland, *University of Colorado, Boulder, CO*

*Primarily intended for ‘beginning graduate students’, this book is highly recommended to anyone seeking to extend their knowledge of differential geometry beyond the undergraduate level.*

—Peter Ruane, *MAA Reviews*

Written in a reader-friendly style, this introduction to the method of moving frames as developed by Cartan includes detailed guidance regarding the use of computer algebra system Maple(TM) in performing many of the computations involved in the book’s exercises.

**Graduate Studies in Mathematics**, Volume 178; 2017; 414 pages; Hardcover; ISBN: 978-1-4704-2952-2; List US\$73; AMS members US\$58.40; Order code GSM/178

*Will you be attending the 2017 CMS Winter Meeting in Waterloo, Ontario from December 8–11? Make sure to stop by the AMS Booth to peruse our latest publications and meet Megan Turcotte, our Director of Membership.*

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## CALL FOR NOMINATIONS - EDITOR-IN-CHIEF

### A Taste of Mathematics (ATOM)

The Publications Committee of the CMS solicits expressions of interest for the Editor-in-Chief position for ATOM. The appointment will be for a five-year term beginning as soon as possible. Currently this position is vacant and we would like to fill this position quickly. **The deadline for submissions is February 15, 2018.**

The booklets in the series, A Taste of Mathematics, are designed as enrichment materials for high school students with an interest in and aptitude for mathematics. Some booklets in the series will also cover the materials useful for mathematical competitions at national and international levels.

Since editorial responsibilities often necessitate a lessening of responsibilities in an individual's normal work, individuals should review their candidacy with their university department.

Expressions of interest should include:

- a formal covering letter;
- a curriculum vitae;
- an expression of views regarding the publication; and
- an inclusion of support from their university department.

Please submit your expression of interest electronically, preferably in PDF format, to: [ATOM-EIC-2018@cms.math.ca](mailto:ATOM-EIC-2018@cms.math.ca)

### Current ATOM Editorial Board

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**Jamie Mulholland** (Simon Fraser), Associate Editor to 12/2020

**Denise Charron** (CMS), Managing Editor

## APPEL DE MISES EN CANDIDATURE - RÉDACTEUR-EN-CHEF

### Aime-T-On les Mathématiques (ATOM)

Le comité des publications de la SMC sollicite des mises en candidature pour le poste de rédacteur-en-chef pour l'ATOM. Le mandat sera pour cinq ans et débutera le plus tôt possible car ce poste est présentement libre. **La date limite pour les soumissions est le 15 février 2018.**

Les livrets de la série, Aime-T-On les Mathématiques, sont conçus comme des matériaux d'enrichissement pour les élèves du secondaire ayant un intérêt et des aptitudes pour les mathématiques. Quelques livrets de la série couvriront également le matériel utile pour les compétitions mathématiques aux niveaux national et international.

Puisque les responsabilités de rédaction nécessitent souvent une réduction dans la charge normale de travail, les individu(e)s devraient vérifier leur candidature avec leur département.

Les mises en candidature doivent inclure :

- une lettre formelle;
- un curriculum vitae;
- l'expression de votre opinion sur la publication; et
- une inclusion d'un soutien de leur département universitaire.

Veuillez soumettre votre mise en candidature par voie électronique, de préférence en format PDF, à : [ATOM-REC-2018@smc.math.ca](mailto:ATOM-REC-2018@smc.math.ca)

### Conseil de rédaction ATOM à présent

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## Fundraising Key to CMS Success

In the spring of 2017, a Fundraising and Communications Officer, Patricia Dack, was hired with the goal of expanding the funds available to support CMS activities. With a full-time staff member responsible for Fundraising, the CMS hopes to obtain more regular donations from foundations, corporations, governments, institutions, friends of the CMS and members who are interested in supporting CMS programs and activities.

Sponsorships and donations from foundations and corporations often have programs that match their employee's donations. Fundraising efforts will continue to support on-going CMS programs such as the Math Competitions, Math Camps, CMS Meetings and Publications.

The CMS encourages you to consider donations by **Planned or Estate Giving**.

### You can help:

Contributing to the CMS. What is most important is your support for the society through regular donations - not necessarily the size of the gift. You can donate online at [cms.math.ca](http://cms.math.ca)

- If you have contacts in private industry who we can contact to explore partnerships, please let Patricia know.
- If you are interested in volunteering for a CMS committee, please contact the chair of the nominating committee at [chair-nomc@cms.math.ca](mailto:chair-nomc@cms.math.ca)
- Encourage colleagues to join the CMS!

Working together, we can promote the advancement, discovery, learning, and application of mathematics. If you have questions or want more information, please contact Patricia Dack at [pdack@cms.math.ca](mailto:pdack@cms.math.ca) or at 613-733-2662 ext. 728.

## Les collectes de fonds : essentielles à l'essor de la SMC

À printemps 2017, la SMC a embauché une agente de la collecte de fonds et des communications, Patricia Dack, dans le but d'intensifier la recherche de financement pour ses activités. Grâce à cet ajout à son personnel à plein temps, la SMC espère recueillir des dons plus réguliers de fondations, d'entreprises, de gouvernements, d'établissements, d'amis de la SMC et de membres désireux de soutenir ses programmes et ses activités.

Les fondations et les entreprises qui font des commandites et des dons ont souvent des programmes qui permettent de jumeler la contribution de leurs employés. Les collectes de fonds permettront à la Société de continuer à financer ses programmes, notamment ses concours et ses camps mathématiques, ses Réunions et ses publications.

La SMC vous invite à réfléchir à la possibilité de faire un don planifié ou par planification successorale.

### Ce que vous pouvez faire :

Contribuer à la SMC. Ce qui compte le plus pour la Société, c'est la régularité de votre don, pas nécessairement le *montant* que vous donnez. Pour faire un don en ligne, passez à la page [smc.math.ca](http://smc.math.ca).

- Si vous connaissez des gens dans le secteur privé que nous pourrions contacter pour discuter de partenariats, veuillez en informer Patricia.
- Si vous avez le goût de faire du bénévolat au sein d'un comité de la SMC, veuillez communiquer avec le président du comité des mises en candidature à l'adresse [chair-nomc@smc.math.ca](mailto:chair-nomc@smc.math.ca).
- Encouragez vos collègues à adhérer à la SMC!

Ensemble, nous pouvons promouvoir l'avancement, la découverte et l'apprentissage des mathématiques, et les applications qui en découlent. Pour toute question ou pour de plus amples renseignements, veuillez contacter Patricia Dack à l'adresse [pdack@smc.math.ca](mailto:pdack@smc.math.ca) ou au 613-733-2662 poste 728.

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