



CMS Summer Meeting / Réunion d'été de la SMC 20

IN THIS ISSUE / DANS CE NUMÉRO

Editorial / Éditorial

Denounce the Alligator / À tout à l'heure, alligateur! ... 2

Calendar / Calendrier 6

Book Reviews / Comptes-rendus de livres

Credit Risk 7

Discovering Discrete Dynamical Systems 8

Education Notes / Les Notes pédagogiques

2018 High School Computer Science
and Mathematics Teacher Workshop:
A Dialogue on CS and Math Education 10

2018 CMS Winter Meeting / Réunion d'hiver
de la SMC 2018 13

Research Notes / Notes de recherche 14

The mathematics of quantum transfer
processes in biological systems 14

CSHPM Notes / Notes de la SCHPM 16

Trivia, Tradition, Truth: Playfair's Axiom 16

André Lichnerowicz Prize in Poisson geometry 18

Call for Proposals / Appel de projets

2018 Endowment Grants Competition / Concours de
bourses du fonds de dotation 2018 19

Call for Nominations / Appel de mises en candidature

2019 Doctoral Prize / Prix de doctorat 2019 21

Canadian Mathematical Bulletin (CMB)
Editor-In-Chief (EIC) / Bulletin canadien de
mathématiques (BCM) Rédacteur en chef 22

2019 Excellence in Teaching Award / Prix d'excellence
en enseignement 2019 23

A Taste of Mathematics (ATOM) Editor-In-Chief /

Aime-T-On les Mathématiques (ATOM)
Rédacteur-en-chef 24

CMS NOTES de la SMC

October/
November
octobre/
novembre
2018

President's Notes / Notes du président

Dr. Termeh Kousha (*University of Ottawa*)
CMS, Executive Director / Directrice de la SMC

Closing the Gender Gap



Since 2007 when I started helping with the CMS Math Camps at the University of Ottawa the strong talent and interest of high school students has always impressed me. I have been amazed how, by using simply cardboard, scissors and tape, the campers were able to create such innovative math projects in only a couple of days.

Math camps play a key role in promoting Mathematics and motivating high school students across Canada. By attending lectures and participating in individual and group competitions, the campers have the opportunity to test their mathematical skills. Every year, Dr. Joseph Khoury, Chair of the CMS Math Camps Committee, receives encouraging feedback from the parents of students who attended these Math camps. The parents highlight the difference the Math camps have made in their child's life and many of them proudly say their child would like to pursue math beyond high school.

Despite the amazing performance of the female campers over the years, recently their numbers have dropped somewhat. It seems that every year fewer female high school students are interested in attending. This is despite the fact that recent studies (1,2) demonstrate that "across all stages of numerical development, analyses consistently revealed that boys and girls do not differ in early quantitative and mathematical ability" (2). The question is why the number of females in STEM fields, especially in the

Un fossé à combler

Depuis 2007 et mes premières animations aux camps mathématiques à l'Université d'Ottawa, je suis impressionnée par le talent et l'intérêt remarquables des élèves du secondaire envers les mathématiques. Je suis étonnée de les voir réaliser des projets innovants en quelques jours à peine avec du carton, des ciseaux et du ruban adhésif tout au plus.

Ces camps sont de formidables outils de promotion des mathématiques et de motivation des élèves de partout au Canada. Au fil des cours et des concours, individuels et collectifs, les campeurs mettent leurs aptitudes à l'épreuve. Le professeur Joseph Khoury, président du Comité des camps mathématiques, reçoit chaque année des commentaires encourageants des parents, qui soulignent avec fierté à quel point la vie de leurs enfants a changé, certains songeant même à continuer les mathématiques au-delà du secondaire.

En revanche, malgré leur succès remarquable, les campeuses semblent être de moins en moins nombreuses chaque année. C'est une tendance contraire aux résultats de deux études récentes (1, 2), selon lesquelles « à tous les stades de l'acquisition des compétences numériques, l'analyse montre de manière constante que les garçons et les filles ne diffèrent en rien au regard de la capacité d'évaluer des quantités et de la capacité mathématique (2) ». Pourquoi, alors, le nombre de femmes, et surtout des plus jeunes, diminue-t-il dans les domaines du bloc science, technologie, ingénierie et mathématiques (STIM)? Et pourquoi les jeunes filles semblent-elles toujours moins attirées par les mathématiques au secondaire?



Denounce the Alligator

Robert Dawson, *St. Mary's CMS Notes Editor-in-Chief*



I'm fascinated by the history of mathematics. Indeed, I'm old enough to have lived through some of it. I learned to use logarithms (in book or slide rule form) to multiply numbers, and remember when "Fermat's Last Theorem" was still a conjecture. (But, contrary to what my students may think, I was not there to throw the apple at Isaac Newton.)

This morning I was browsing through a battered copy of Walkingame's Tutor's Assistant, an English mathematics textbook that was first published before the American Revolution and stayed in print for over a century. Interesting reading!

Much pre-modern mathematics is quite functional. The algorithms that our ancestors learned for computing (for instance) square roots worked with reasonable efficiency. Yes, they were somewhat opaque, but no more so than the algorithms locked away inside the chip of a graphing calculator. But there are certainly places where things have improved. While many scientists did excellent work without the aid of the metric system, it is certainly more convenient than the old Imperial units in which no two units seemed to be in the same ratio. Barleycorns, inches, feet, rods, furlongs, miles... In Britain, even the currency was bizarre - there were, believe it or not, sixty-three groats in a guinea.

You may remember these lines:

"Multiplication is vexation
Division is as bad,
The Rule of Three doth puzzle me
And Practice drives me mad."

Well, the multiplication and division were done longhand. "Practice" was a set of rules for speeding up calculations with those awkward units. The Rule of Three was a technique for setting up problems involving linked ratios: if a hen and a half lays an egg and a half in a day and a half, how long does it take a dozen hens to lay a dozen eggs? And then there was Alligation.

"Alligation Medial" was actually a primitive form of linear algebra, dealing with mixtures of commodities. You mix 10 bushels of corn at 4 shillings per bushel with 5 bushels of wheat at 7 shillings per bushel and 7 bushels of oats at 3 shillings per bushel; what should the price of a bushel of the mixture be?

"Alligation Alternate" was the inverse problem: what ratios should be used if the mixture is to sell at a given price? Often, there were three or more components, so that the problem was underdetermined. The desired answer was not, as it would be today, a parametric formula for all answers, but one arbitrary answer, found through an ad hoc rule. There really is there is some mathematics that we are better off without. To borrow an old line, I deny the alligation, and denounce the alligator!

À tout à l'heure, alligateur!

L'histoire des mathématiques me fascine. De fait, je suis assez vieux pour en avoir vécu quelques chapitres. J'ai appris à multiplier à l'aide de logarithmes (avec une table ou une règle à calcul) et je me souviens de l'époque où le dernier théorème de Fermat était encore une conjecture. (Contrairement à ce que pourraient croire mes étudiants, cependant, je n'étais pas là pour jeter la pomme à Isaac Newton.)

Ce matin, je parcourais un exemplaire délabré du *Tutor's Assistant* de Walkingame, un manuel de mathématiques anglais paru pour la première fois avant la Révolution américaine et réimprimé à plusieurs reprises pendant plus d'un siècle. Quelle lecture passionnante!

En général, les mathématiques prémodernes sont très fonctionnelles. Les algorithmes que nos aïeux apprenaient, par exemple pour extraire une racine carrée, étaient raisonnablement efficaces. Certes, on peut leur reprocher une relative opacité, mais pas plus qu'aux algorithmes enfermés dans la puce d'une calculatrice graphique. Il reste que certains aspects se sont indéniablement améliorés. Beaucoup de scientifiques ont fait un excellent travail sans l'aide du système métrique, mais celui-ci est évidemment plus pratique que les anciennes unités impériales, qui avaient presque toutes des rapports différents. La ligne, le pouce, le pied, la perche, le sillon, le mille... En Grande-Bretagne, même les unités monétaires étaient bizarres – il fallait, croyez-le ou non, soixante-trois groats pour changer une guinée.

Bien des Anglo-Saxons ont seriné ce quatrain :

« La multiplication me vexe,
La division itou,
Si la règle de trois m'intrigue,
La pratique me rend fou. »

Voyons cela de plus près. La multiplication et la division se faisaient à la main. La « pratique » est un ensemble de règles destinées à accélérer le calcul de ces unités incommodes. La règle de trois est une technique de présentation des problèmes de proportion; si une poule et demie met un jour et demi à pondre un œuf et demi, combien de temps faut-il à une douzaine de poules pour pondre une douzaine d'œufs? Et puis il y avait l'alligation.

L'« alligation médiale » est en fait une forme primitive d'algèbre linéaire qui a trait aux mélanges de marchandises. On mélange 10 boisseaux de maïs à 4 shillings le boisseau, 5 boisseaux de blé à 7 shillings le boisseau et 7 boisseaux d'avoine à 3 shillings le boisseau; quel devrait être le prix d'un boisseau de ce mélange?

L'« alligation alterne » est le problème inverse : quelles proportions doit-on utiliser pour vendre le mélange au prix donné? Souvent, il y avait trois variables ou plus, de sorte que le problème était sous-déterminé. La réponse recherchée n'était pas, comme aujourd'hui, une formule paramétrique regroupant toutes les réponses possibles, mais une seule réponse arbitraire établie selon une règle ponctuelle.

Il y a vraiment des aspects des mathématiques dont nous pouvons très bien nous passer. Pour paraphraser un prévenu, je nie cette alligation et je dénonce l'alligateur!

Letters to the Editors

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

Lettres aux Rédacteurs

Les rédacteurs des NOTES acceptent les lettres en français ou en anglais portant sur n'importe quel sujet d'intérêt mathématique, mais ils se réservent le droit de les 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.

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Le renouvellement pour l'an 2019 va commencer bientôt! S'il vous plaît renouveler votre adhésion en ligne dès que possible à portal.cms.math.ca et en vous connectant à votre compte de membre. Si vous avez des questions, s'il vous plaît écrivez-nous à adhessions@smc.math.ca

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

CMS NOTES

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Continued from cover

younger ages, is decreasing and fewer female high school students appear attracted to math?

High schools play an important part in shaping the future of students. During that time the students start planning for their future and many of them decide which degree they want to pursue in university. If we want to encourage them to pursue careers in the mathematical sciences, we need to start this encouragement in high schools. Maybe by encouraging successful women in math to come talk in the high schools, we can help female students overcome fear of failure in math. Also, we can do more presentations in high school about careers in Mathematics, inform the students about the equal abilities of women in STEM and encourage them to participate in Math camps. A study (3) at Florida State University shows that girls rate their abilities markedly lower than boys. Another study shows that in more gender-neutral countries such as Norway and Sweden the math gender gap has disappeared (4). There is no reason why we should not be able to eliminate this gap in the near future in Canada. Currently, based on an article in Macleans magazine, gender inequality in STEM is still very real for Canadian women.

As the successor to Dr. Graham Wright in my position as the new Executive Director of the CMS, beyond all the new and exciting challenges I am facing, I would like to invest more time with high school students and promote math at that level. I believe this is the age when we have to tackle the stereotypes and strive to show female students all the successful women in STEM in order to increase their confidence and career opportunities. By encouraging female students to pursue a math degree in university, not only will

they find a good career in the future, but Mathematics will change the way they think and will help them in all aspects of their life.

Dr. Graham Wright has been an Executive Secretary and the key contributor to the CMS since 1979. His exceptional enthusiasm, dedication and passion have been one of the main reasons of the success of the CMS. I am looking forward to continuing his path and passion and use his invaluable experience to take a leading role in the Society.

Reference:

- [1] Women in Academic Science. A Changing Landscape (2014). *Psychological Science in the Public Interest*. Stephen J. Ceci, Donna K. Ginther, Shulamit Kahn, Wendy M. Williams.
- [2] No intrinsic gender differences in children's earliest numerical abilities (2018) *Science of Learning volume 3, Article number: 12*. Alyssa J. Kersey, Emily J. Braham, Kelsey D. Csumitta, Melissa E. Libertus & Jessica F. Cantlon
- [3] Gendered Pathways: How Mathematics Ability Beliefs Shape Secondary and Postsecondary Course and Degree Field Choices (2017) *Frontiers in Psychology*. Lara Perez-Felkner, Samantha Nix, and Kirby Thomas.
- [4] Diversity. Culture, gender, and math (2008) *Science* Guiso L, Monte F, Sapientza P and Zingales L

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Suite de la couverture

C'est au secondaire que se dessine en grande partie l'avenir des élèves. C'est pendant ces cinq années, en effet, que les élèves commencent à planifier leur avenir. Beaucoup visent déjà un grade précis à l'université. Pour les encourager à faire carrière dans les sciences mathématiques, il faut donc commencer dès cette période. Peut-être pourrions-nous inviter de brillantes mathématiciennes à l'école, pour aider les filles à surmonter leur crainte d'échouer dans cette discipline. Essayons de leur présenter davantage la gamme des carrières possibles en mathématiques, de montrer aux élèves que les femmes peuvent tout aussi bien que les hommes maîtriser les STIM et d'encourager les filles à participer aux camps mathématiques. Selon une étude de la Florida State University (3), les filles jugent elles-mêmes que leurs capacités sont sensiblement inférieures à celles des garçons. Une autre étude montre que dans des pays où le genre est moins socialement valorisé, comme la Norvège et la Suède, la disparité entre garçons et filles au regard des mathématiques s'est résorbée (4). Il n'y a pas de raison que nous ne faisions pas de même au Canada. S'il faut en croire un article paru dans le magazine *Maclean's*, l'inégalité entre les sexes au regard des STIM est encore très réelle pour les Canadiennes.

Je prends la suite de Graham Wright au poste de directrice administrative de la SMC avec l'idée d'ajouter à tout ce qui m'attend de nouveau et de stimulant, une tournée des écoles secondaires afin d'y promouvoir les mathématiques. Je crois en effet que c'est à cet âge qu'il faut attaquer les stéréotypes et faire connaître toutes ces femmes qui font de brillantes carrières dans les STIM, afin de stimuler la confiance en soi des jeunes filles et élargir leurs perspectives professionnelles. Non seulement un grade en mathématiques peut déboucher sur de belles carrières, mais cette discipline changera leur façon de penser et les aidera dans toutes les facettes de leur vie.

Depuis 1979, Graham Wright a été le fer de lance de la SMC, dont il a été également le secrétaire général. Son enthousiasme, sa passion et son dévouement exceptionnels ont largement contribué au succès de la Société. Je savoure l'idée de marcher sur ses traces, d'entretenir la passion et de tirer parti de sa précieuse expérience pour jouer moi aussi un rôle de premier plan à la SMC.

Sources

- [1] Stephen J. Ceci, Donna K. Ginther, Shulamit Kahn, et Wendy M. Williams. « Women in Academic Science. A Changing Landscape », *Psychological Science in the Public Interest*, 2014.
- [2] Alyssa J. Kersey, Emily J. Braham, Kelsey D. Csumitta, Melissa E. Libertus, et Jessica F. Cantlon. « No intrinsic gender differences in children's earliest numerical abilities », *Science of Learning*, vol. 3, article nº 12, 2018.
- [3] Lara Perez-Felkner, Samantha Nix, et Kirby Thomas. « Gendered Pathways: How Mathematics Ability Beliefs Shape Secondary and Postsecondary Course and Degree Field Choices », *Frontiers in Psychology*, 2017.
- [4] Luigi Guiso, Ferdinando Monte, Paola Sapienza, et Luigi Zingales. Diversity. Culture, Gender, and Math, *Science*, vol. 320, nº 5880, 2008.

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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)



OCTOBER 2018 OCTOBRE

Sept 30-5	BIRS Workshop: Spin Glasses and Related Topics , BIRS, Banff, Alta.
1-5	Women in Academic Leadership , Inn at The Forks, Winnipeg, Man.
3-5	CRM-PCTS Workshop: Critical Phenomena in Statistical Mechanics and Quantum Field Theory , Princeton University, Princeton, U.S.A.
5-6	Fall 2018 West Coast Optimization Meeting , University of British Columbia, Okanagan, BC
7-12	BIRS Workshop: Moduli Spaces: Birational Geometry and Wall Crossings , BIRS, Banff, Alta.
12-14	62e Congrès de l'Association de mathématiques du Québec (AMQ), Cégep de Saint-Laurent, Montréal, Qué.
12-14	Science Atlantic Math/Stats/Computer Science Conference, Université de Moncton, Moncton, N.B.
14-19	BIRS Workshop: Fusion Categories and Subfactors , BIRS, Banff, Alta.
15-19	CRM Workshop: Quantum Information and Quantum Statistical Mechanics , CRM, Montreal, Que.
19	PIMS UBC-Math Distinguished Colloquium: Jeremy Quastel , University of British Columbia, Vancouver, BC
21-26	BIRS Workshop: Crossing Numbers: Theory and Applications , BIRS, Banff, Alta.
21-26	BIRS Workshop: Hessenberg Varieties in Combinatorics, Geometry and Representation Theory , BIRS, Banff, Alta.
22-26	Workshop on Dynamics and Moduli Spaces of Translation Surfaces, The Fields Institute, Toronto, Ont.
28-Nov 2	BIRS Workshop: Intersection of Information Theory and Signal Processing: New Signal Models, their Information Content and Acquisition Complexity , BIRS, Banff, Alta.
29-Nov 2	CRM Workshop: Entropic Fluctuation Relations in Mathematics and Physics , CRM, Montreal, Que.

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
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NOVEMBER 2018 NOVEMBRE

4-9	BIRS Workshop: WOA: Women in Operator Algebras , BIRS, Banff, Alta.
5-9	2018 Fields Medal Symposium, The Fields Institute, Toronto, Ont.
9	Putting Women Into the Equation: Changing Dynamics in Research , The Fields Institute, Toronto, Ont.
10-11	ABC Algebra Workshop , University of Washington, Seattle, U.S.A.
11-16	BIRS Workshop: Mathematical and Statistical Challenges in Bridging Model Development, Parameter Identification and Model Selection in the Biological Sciences , BIRS, Banff, Alta.
12-16	CRM Workshop: Spectral Theory of Quasi-Periodic and Random Operators , CRM, Montreal, Que.
17	2018 Combinatorial Potlatch, Simon Fraser University, Vancouver, BC
18-23	BIRS Workshop: Unifying Themes in Ramsey Theory , BIRS, Banff, Alta.
25-30	BIRS Workshop: Model Theory and Operator Algebras , BIRS, Banff, Alta.

DECEMBER 2018 DÉCEMBRE

2-7	BIRS Workshop: Integrating the Integrators for Nonlinear Evolution Equations: from Analysis to Numerical Methods, High-Performance-Computing and Applications , BIRS, Banff, Alta.
7-10	2018 CMS Winter Meeting/Réunion d'hiver de la SMC 2018, Sheraton Vancouver Wall Centre, Vancouver, B.C.
9-14	BIRS Workshop: Shape Analysis, Stochastic Mechanics and Optimal Transport , BIRS, Banff, Alta.
11-14	CRM Workshop: Workshop on Mathematical and Computational Methods for Quantum Systems , CRM, Montreal, Que.

JANUARY 2019 JANVIER

16-19	2019 Joint Mathematics Meetings (JMM) , Baltimore, Maryland, U.S.A.
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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.

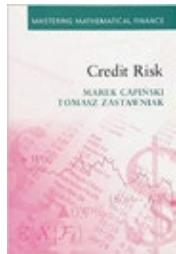
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Credit Risk

by Marek Capiński and Tomasz Zastawniak
Cambridge University Press, 2017

ISBN 978-0-521-17575-3

Reviewed by John Rumsey, Dalhousie University



Consider a financial security (a loan) which promises to pay a unit amount on a specific date. If the payment is guaranteed, so that the security is riskless, then today's price of the security will be some amount smaller than unity. If there is a chance that the payment will not be made, then we expect that today's price of the risky security will be smaller than the price of the riskless security. The difference between the prices of the two securities is a measure of the credit risk of the risky security.

Today's price is the present value of the promised future payment, using some discount, or interest, rate and the difference between the discount rates of the two securities, called the credit spread, is a common measure of credit risk. The challenge of the study of credit risk is to model the credit spread.

The Capiński and Zastawniak "Credit Risk" text provides a mathematically rigorous approach to this problem. The preface tells us that the reader needs to be familiar with the foundations of stochastic calculus and the Black-Scholes model, but says that "exposure to measure theory based probability ... would also be helpful." The suggestion that familiarity with measure theory based probability is not so important as familiarity with stochastic calculus and the Black-Scholes model, is misleading. Probability theory is widely used throughout the text to derive general results, while the stochastic calculus and the Black-Scholes model mathematics are primarily used only in Chapters 1 and 6.

The text derives collections of results for two classic approaches to the credit risk problem, known as the structural model approach and the reduced-form approach. The structural model approach uses the classic Black-Scholes-Merton option pricing models and requires no familiarity with probability theory. It requires only some familiarity with the Black-Scholes pricing formula and with risk-neutral probabilities.

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 les bienvenus.

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The reduced-form approaches are the major part of the text, and require familiarity with concepts such as martingales, filtrations, and the Girsanov and Radon-Nikodym theorems, as well as with notation which is specific to probability theory. While the appendix gives some results (Lebesgue-Stieltjes integral, Passage time and minimum of Wiener process, and Stochastic calculus with martingales) the reader would benefit from a reminder of the probability theory definitions, theorems, and notation used in the text.

Apart from this small frustration, the text is well-organised and presents the material clearly and with great detail. There is an abundance of accessible numerical examples. These are used to illustrate and motivate general results and to reinforce the implications of the general results. There are also many exercises of widely varying difficulty. These exercises are presented, not at the end of the section, but in that part of the body of the text to which they apply. Further, the website for the text provides numerical details of the text examples and full solutions to the examples. The algebra of this material is generally very ugly, but the presentation is sufficiently detailed that reference to the website for the numerical details is usually unnecessary.

The structural model approach, Chapter 1, uses the observation that the value of the equity of a limited liability firm with debt can be modelled as a call option written on the firm's assets. The strike price of the call (as the firm's equity) is the promised debt repayment, and if this is less certain, lenders will require the promised payment to be larger. Consequently, the value of the equity will be smaller. The text then uses traditional option pricing models to solve numerically for the strike price. Expressing this as the future value of today's debt, we can obtain the interest rate on risky debt and hence compute the credit spread. Some elegant results are demonstrated for a rich variety of debt instruments.

Most of the text, Chapters 2 to 6, uses the so-called reduced form approach to study credit risk. A goal is to show the existence of risk-neutral probability Q , impose the no arbitrage constraint, and to use self-financing replicating portfolios to derive results about security prices.

To accomplish this, the uncertain time of default is used to define a hazard function and a default indicator process, which is used to generate a filtration. The defaultable bond price is assumed to be adapted to this filtration. Initially, the replicating portfolio consists of a defaultable bond and a riskless default-free bond. In Chapter 5 a risky default-free asset (such as a share of equity) is added.

In Chapter 2, necessary and sufficient conditions are derived for the arbitrage-free price of a defaultable bond. An important result of Chapter 2 is to prove the existence of a risk-neutral probability Q so that the price of a defaultable bond is the present value, at riskless rate, of the expected payoff under Q .

In Chapter 3, the probability Q is assumed to exist and to be equivalent to the real-life probability. By modelling or assuming a term structure of interest rates, a process of defaultable bond prices is derived in terms of hazard function. Because security pricing is typically derived using replicating portfolios, and because the discounted values of replicating strategies should be martingales under the risk-neutral probability Q , much of Chapter 3 derives martingale properties associated with the default indicator process.

Chapter 4 extends the results of Chapter 3 proving first a theorem about admissible replicating strategies. This is used to derive a price of a defaultable bond with partial recovery, and the price of a Credit Default Swap.

Chapter 5 adds a default-free risky security. The variability in its price is given by the standard Black-Scholes Wiener process, which generates another filtration. The sigma-field formed by the union of the two filtrations yields an enlarged filtration which includes the information in both the default-free and defaultable market segments. Allowing the default time to be affected by the variability in the risky security means that instead of a deterministic function we now have a hazard process. In Chapters 5 and 6, the text then reworks many of the results of Chapters 3 and 4 based on the enlarged filtration.

This is clearly not an introductory text, but its clarity and attention to detail make its study a satisfying and rewarding effort.

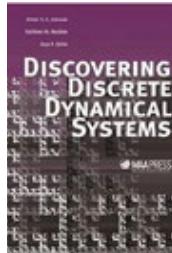
Discovering Discrete Dynamical Systems

by Aimee S. A. Johnson, Kathleen M. Madden, and Ayşe A. Şahin

MAA Press, 2017

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Reviewed by *Tara Taylor*, St. Francis Xavier University



This book is an engaging and thoughtful resource for inquiry-based learning of dynamical systems. It differs from the usual math textbooks in that it doesn't provide complete details but rather offers topics that encourage the readers to explore, discover, and learn independently. There is a growing demand for more resources for active learning

in the classroom, and this book is a wonderful resource for a course on dynamical systems. In fact, it could be used for a more general introduction to math research course. The functions involved aren't that complicated – linear, quadratic, some trigonometry. The material connects various areas of math – topology, linear algebra, fractals, etc. It is meant for students/independent learners who have the prerequisites for a course in real analysis (so calculus and linear algebra).

There are 14 modules, each of which could be done in about 3 to 4 classes. A module starts with an open-ended question (with topics ranging from an exploration of the logistic family of equations to the chaos game to a specific dynamical system) to motivate discussions that will lead to theory. The open-ended question is never followed by an exposition that overtly answers the questions. This can be frustrating for students (and instructors!) who are used to standard exposition type textbooks, but the challenges can lead to deeper learning. They include proofs of theoretical results, examples of specific systems, connections with other areas of math, and applications (for instance, the growth of bacteria in a petri dish). The exercises are well-thought out to offer the students different ways to test their understanding of the concepts but to also help them build upon the theory presented. Each module ends with a project. This could be done in a group or alone.

For example, Module 1 is on fixed points of dynamical systems and starts with an exploration of the logistic family of equations

$$g_c(x) = cx(1 - x),$$

with iterates $g(x_0), g^2(x_0) = g(g(x_0)), \dots$ in terms of initial value x_0 and parameter c . This is a good example to start with as it is accessible for students, it can be fun to experiment with different initial values and parameters, and there are many avenues for analysis. The exposition for Module 1 gets into definitions and terminology of concepts like dynamical system, initial conditions, orbits, attracting/repelling fixed points, basins of attraction, and discusses the monotone convergence theorem. The project for

Module 1 involves a cute card trick that relies on the power of attracting fixed points.

As the material is not spelled out for the students, it is not spelled out for the instructor either. There are no solutions to the exercises, so an instructor would need to be either quite familiar with the material or have time to develop solutions. An instructor may wish to have a list of suggested readings available for the students to go along with this book. The book itself offers recommendations for further reading, and the bibliography contains only 21 references (this is nice in that it isn't too overwhelming); these are all fairly accessible either online or in most university libraries. The book suggests that the course could involve a final paper/project but doesn't offer any specific guidelines for that. The material requires the use of technology, especially for the iteration of functions. This could be provided with some basic coding (Mathematica, Maple, Excel, etc.) or one could get the students to do the programming.

The most important thing for an instructor to do is the hardest – to step back and give the students time to struggle. The students might learn fewer facts than in a typical course, but they get to experience the challenge and thrill of mathematical discovery. It is very rewarding for an instructor to witness this growth in confidence and self-sufficiency. The book forces the students to experience struggle and frustration, but also the joys that come from the Eureka moments. The language in the book is fairly straightforward for a student or independent learner to read – the main difficulty is that the theory is not spelled out so that the reader has to do more work on their own. There is good use of diagrams throughout. Some other highlights include a project that uses the understanding of periodic points to prove Fermat's little theorem $a^p - a \equiv \text{mod } p$ and Sharkovskii's ordering of the natural numbers $(3, 5, 7, \dots, 2 \cdot 3, 2 \cdot 5, 2 \cdot 7, \dots, 2^2 \cdot 3, 2^2 \cdot 5, 2^2 \cdot 7, \dots, \dots, 2^4, 2^3, 2^2, 2, 1)$. I admittedly was unfamiliar with Sharkovskii's rather counter-intuitive ordering so I am grateful to have stumbled upon this gem. Module 10 starts with the chaos game that many readers may recognize as leading to the Sierpiński gasket, but there is no mention of the gasket. The further reading suggests books on fractals and this is a case where the instructor would really need to know more than what the book is presenting. The book claims that it will enable students to develop persistence and skill in exploration, conjecture and generalization; to apply principles of real analysis to study dynamical systems; to read math independently; and to communicate math with clarity. I believe that the book has met these goals, and I encourage instructors to use it for a course on dynamical systems (or a more general math research course).



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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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Les 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 les bienvenus.

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University instructors spend a lot of time with their students. High school teachers spend a lot of time with their students. Yet, there are no existing built-in opportunities for university instructors and high school teachers to interact. This article describes an initiative that aims to establish this missing link and build a communication bridge between the two groups.

2018 High School Computer Science and Mathematics Teacher Workshop: A Dialogue on CS and Math Education

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Every year, the Department of Mathematical and Computational Sciences at the University of Toronto Mississauga (UTM) in Mississauga, Ontario collaborates with the Google Educator Professional Development Program to host a High School Teacher Workshop with computer science (CS) and mathematics teachers from the Greater Toronto Area and its surrounding cities and towns. The aim of the workshop is to collaborate with high school teachers about the ways in which first-year computer science and mathematics courses at UTM have evolved to adapt to the changes in the local Ontario high school curriculum and to openly discuss the teachers' insights and experiences with Grade 11 and 12 computer science and mathematics courses.

The purpose of this article is to inform and inspire other universities across Canada to create a community of practice with high school teachers and university instructors. Our local small initiative is designed to assist and better prepare students in fairly challenging transition from high school to university. This community of practice would be especially beneficial for universities that predominantly have a larger domestic (local) student population. With this in mind, the events of this year's high school computer science and mathematics teacher workshop at UTM are presented here to

enable other Canadian universities in potentially adopting similar initiatives and activities for their local contexts.

With the help of the Robert Gillespie Academic Skills Centre at UTM, the workshop entitled *Dialogue on CS and Math Education* was hosted in early June 2018. The objective was to create an on-going conversation between high school teachers and university instructors to better support and guide their students for success in their academic endeavours. All workshop activities had a focus on teaching strategies that could be brought into both high school and university classrooms, and our dialogue included discussions on the challenges and successes that all educators experience when teaching students in the transitional period from Grade 12 high school to first-year university.

The high school teacher workshop was a two-day event. The first day was devoted to "hands-on" activities and the second day focused on the perspectives on computer science and mathematics education from the standpoint of university instructors, high school teachers, and first-year undergraduate students. It consisted of three computer science sessions and three mathematics sessions each day. Workshop participants were able to choose a mix of sessions they wanted to attend. But, the key feature of all sessions in the workshop was an open dialogue where questions were always welcomed at any point, which in turn created healthy discussions about computer science and mathematics education.

Day One

Computer Science Sessions

On the first day, the computer science sessions consisted of learning, playing, and being creative all at once. The first session was inspired by a Reddit.com post – by the inventor himself – about a new and exciting board game, Turing Tumble (www.turingtumble.com), whose aim is to help anyone to learn how a computer works and how to think logically about coding. Turing Tumble was an instant success amongst the high school CS teachers. As the high school teachers and university instructors together brought out their

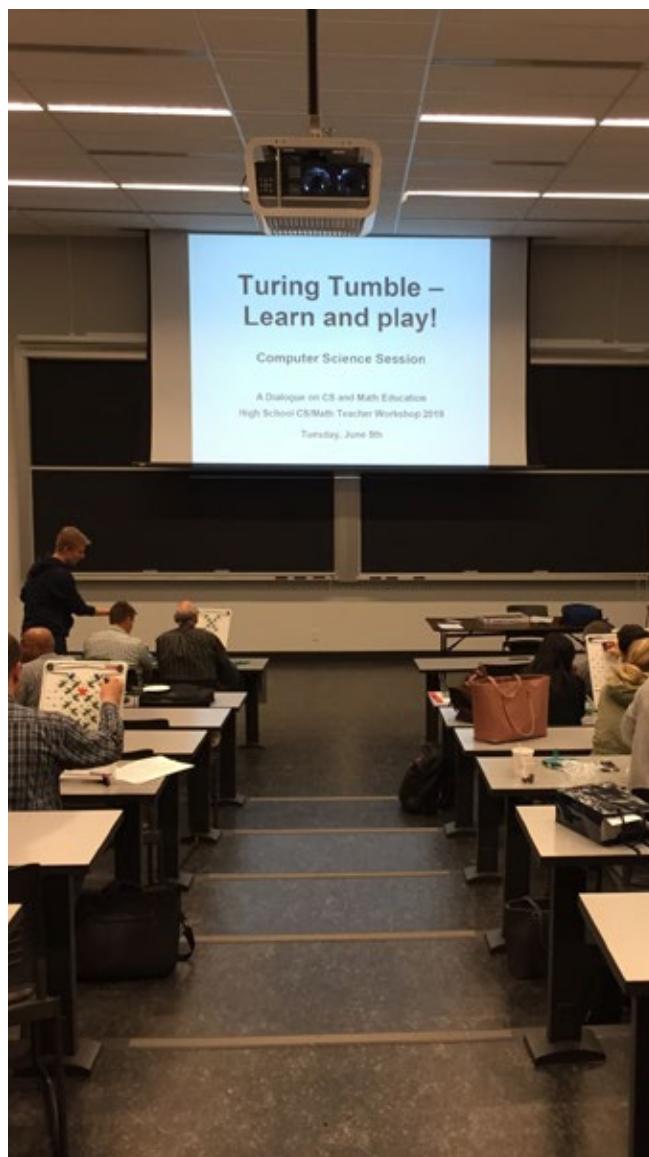
inner-child and played with the board game, the general impression was that Turing Tumble was well suited for any introductory computer science course. The second CS session allowed for the creative juices to flow with PyGames (PyGames is a collection of modules written in Python – a programming language, designed for creating video games. It includes computer graphics and various libraries that make programming easier). High school teachers and university instructors were engaged with PyGames demos. One demo, in particular, allowed the user to develop their coding skills by starting with a block and creating eventually a fire truck that moved across the screen – it was neat to see the evolution from the block to something more elaborate. The last session was dedicated to high school CS teachers to actually see the first few assessments (e.g., assignments, labs, and term tests) that were used in first-year CS courses. This was an opportunity to see how CS learning was gauged in new, CS-focused students and, also, to consider the challenges that university instructors face in assessing their students. In turn, high school teachers were encouraged to share with university instructors assessments that were administered in their own high school CS courses.

Mathematics Sessions

On the mathematics spectrum of activities, the first session of the first day exposed high school mathematics teachers to the Calculus Readiness Assessment (CRA), which is a pre-calculus test for new undergraduate students taking any first-year calculus course at UTM. High school mathematics teachers were encouraged to answer the multiple choice questions on the CRA to experience and learn the expectations imposed on the incoming UTM undergraduate students – some teachers were pleasantly surprised at the level of difficulty of some of the questions. Generally, the CRA is administered to help students to identify strengths and weaknesses in their mathematical background – similar calculus assessments are used at other universities across Canada. The second session was composed of a demonstration and discussion, by a high school mathematics teacher, about the Smartboard experience. Instead of using the good old chalk and chalkboard in this ever-growing tech savvy world, workshop participants were able to see how a tablet could be used to project lessons, videos, and notes to make the classroom experience more interactive and open to all different learning styles. The final session was devoted to the transition in assessments. High school mathematics teachers perused the first term-test for each first-year calculus course at UTM. This session provided a great opportunity to explore the expectations that would shape university assessments. In turn, high school teachers were encouraged to share with university instructors' specific information about the high school assessments.

Day Two

The second day of the high school teacher workshop was a platform for university instructors, high school teachers, and first-year students to have their voices heard. Both the CS sessions and the math sessions had the same setup. The first session allowed for university instructors to share with the high school teachers the classroom challenges and successes in a first-year computer science and mathematics course. High school teachers found the session to be rather eye-opening, yet somewhat refreshing because they can relate to the triumphs and frustrations when teaching. The second session was reserved for the high school teachers to take the microphone literally. As the high school teachers registered for the workshop, they were asked to write any questions and/or concerns that they wanted to be addressed during the workshop. University instructors collaborated with the high school teachers in an effort to come up with resolutions and/or options including suggestions of various educational resources and publications





pertinent to the issues. A lot of enthusiasm was felt in the sessions on all sides with a common thread of wishing to better the success of students in the transition from high school to university. Finally, the most important session of the second day was listening to the first-year students – yes, the ones that we teach. A few computer science and mathematics undergraduate students, who recently finished their first-year courses, voluntarily participated and shared their experiences. The students thoroughly enjoyed voicing the good, the bad, and the ugly when they took first-year courses in computer science and mathematics and felt that they were heard.

At the end of the second day of the high school teacher workshop, high school teachers were asked to fill out a quick feedback form – the responses would be used to improve and modify the workshop in its future iterations. Overall, both computer sciences and mathematics sessions were a hit! The high school teachers felt that some of the conversations throughout the workshop helped them justify what they had done already in the classroom – it gave them a sense of reassurance. They enjoyed the Q&A style and found the information discussed beneficial to their high school students who were planning to attend university. They were grateful to learn what the university expectations of first-year computer science and mathematics courses were and appreciated UTM being so willing to create this community of practice between high school teachers and university instructors. The general consensus from all workshop participants was, as one high school teacher wrote, “[the workshop] felt like a support group for cs and math educators who actually care à very ‘therapeutic’.”

Going Forward

The high school teacher feedback responses will be used for the next iteration of the workshop in the following academic year. Some ideas that high school teachers presented were: inviting senior administration and school board representatives to attend to hear the issues at the secondary and tertiary levels of education, even having media attend, having high school teachers experience a real computer science or mathematics lecture during the workshop, and creating tools collaboratively with high school teachers and university instructors to encourage more students to take computer science and mathematics courses and to better prepare students for their first-year studies at a university. Hopefully, these suggestions will be incorporated in the next high school teacher workshop, because by means of such collaborative efforts, high school teachers and university instructors can learn more about their students and be better positioned to assist students as they make a transition to university.

For further details and questions about the 2018 High School Computer Science and Mathematics Teacher Workshop: A Dialogue on CS and Math Education, please visit the link (www.utm.utoronto.ca/math-cs-stats/outreach/2018-high-school-teacher-workshop-computer-science-and-mathematics) or contact directly Tyler Holden (tyler.holden@utoronto.ca) and/or Andie Burazin (a.burazin@utoronto.ca).

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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.

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The mathematics of quantum transfer processes in biological systems

Marco Merkli, Memorial University

Quantum donor-acceptor (*D-A*) systems are basic models for the transfer of matter, energy and charge. In quantum chemistry, they are used to study electrons jumping from a donor to an acceptor chemical species. Canadian chemist Rudolf Marcus was awarded the Nobel Prize in 1992 for his theory explaining energy transfer reactions [4, 5]. More recently it was realized that similar mechanisms are at the core of processes in biological systems, specifically in photosynthesis in plants and bacteria. While classical models are not able to render correct predictions for the experimentally established data in photosynthetic processes, quantum models are [7]. A plant or bacterium captures a sunlight photon, which energetically excites a chlorophyll molecule electron. This excitation is then transferred, extraordinarily quickly and virtually without loss, along a chain of donor and acceptor chlorophyll molecules, until it reaches a reaction centre where the excitation facilitates slower chemical reactions.

Crucially, *D-A* systems interact with surrounding molecules and are thus *open* (not isolated). The ‘noisy’ surrounding environment is typically modeled by a collection of many oscillatory degrees of freedom. The paradigmatic such open model is the spin-boson system [3], which describes a two level quantum system (spin) interacting with a quantum field (free bosonic degrees of freedom). Interpreting the two levels as the excited states of a donor and an acceptor, the spin-boson model suitably describes the open *D-A* system. The *D* and *A* are occupied (host the excitation) with probabilities $p_D \in [0, 1]$ and $p_A = 1 - p_D$, respectively. Of key interest is the time evolution of the donor probability, $p_D(t)$, e.g. knowing that *D* is initially fully occupied (has captured a photon) and that the quantum field is in equilibrium at a given (say, room) temperature. According to the postulates of quantum theory,

$$p_D(t) = \langle e^{-itL} \Psi_0, P e^{-itL} \Psi_0 \rangle. \quad (1)$$

Here, $\langle \cdot, \cdot \rangle$ is the inner product of the Hilbert space \mathcal{H} describing the whole system and $\Psi_0 \in \mathcal{H}$, $\|\Psi_0\| = 1$, is the initial state of *D-A* plus environment. As prescribed by the Schrödinger equation, the state at time t is $e^{-itL} \Psi_0$, where $\mathbb{R} \ni t \mapsto e^{-itL}$ is a unitary group on \mathcal{H} , generated by a selfadjoint L , called the Liouvillian. P in (1) is an orthogonal projection, playing the role of the ‘observable’ corresponding to the donor probability (other

physical quantities correspond to other operators). The concrete form of H , L and P are well known for the open *D-A* system.¹ There are two ‘coupling constants’ in L : $\Delta \geq 0$ measures the strength of the direct (e.g. ‘dipole-dipole’) interaction between *D* and *A* while $\lambda \geq 0$ measures that of *D-A* with the environment. The values of these parameters are known from experiments and in the biological systems of interest, the environment coupling is strong, $\lambda \gg \Delta$. Accordingly, one is led to decompose the Liouvillian as

$$L = L_0(\lambda) + \Delta I, \quad (2)$$

where the ‘unperturbed operator’ $L_0(\lambda)$ generates the dynamics for the *D-A already coupled to the environment* ($\lambda \neq 0$), and the operator I describes the direct interaction between *D* and *A*. Usually in open systems, perturbation theory is done in small couplings to the environment, the unperturbed case being simply the *uncoupled* system and environment. Here though, it must be done in the internal system parameter Δ and the unperturbed case is the *D-A* already interacting with the environment. Nevertheless, using a ‘polaron transformation’ one can solve the dynamical problem for $L_0(\lambda)$ exactly, so (2) is suitable for a perturbation theory in Δ . However, in the strongly coupled situation at hand, L lacks sufficient ‘regularity’ for standard methods (spectral deformations, standard Mourre theory) from the spectral analysis of Liouvillians to apply. Still, it is possible to develop a ‘singular Mourre theory’ to deal with this case [1, 2]. The main result is an expansion of the propagator e^{itL} for a class of operators L including Liouvillians as described above. The expansion exhibits oscillatory and decaying (in time) directions of the dynamics in Hilbert space.

Expansion of the propagator. Let $L = L_0 + \Delta I$ be a selfadjoint operator on a Hilbert space \mathcal{H} , such that the selfadjoint L_0 has eigenvalues e , with multiplicities m_e , embedded in continuous spectrum. As $\Delta \neq 0$, every e is either unstable (L does not have any eigenvalues close to e , as $\Delta \neq 0$), or it bifurcates into a group of ($\leq m_e$) real eigenvalues. In the latter case we say e is partially stable and we assume here for simplicity that partially stable e undergo a reduction to dimension one, denoting by $E_e = e + O(\Delta) \in \mathbb{R}$ the associated eigenvalue of L . Under the assumptions that (1) the first order perturbation terms vanish

¹ We are dealing with a spatially infinitely extended reservoir in thermal equilibrium, and so the Gelfand-Naimark-Segal construction of the thermal Weyl C^* -algebra is used to find the Hilbert space representation. The Liouvillian is not unique and one takes advantage of the Tomita-Takesaki theory of von Neumann algebras to construct a version of L suitable for the further analysis.

$P_e I P_e = 0$ (P_e being the spectral projection of L_0 associated to e), (2) the (formal) second order perturbation terms are non-degenerate (Fermi Golden Rule Condition) and (3) the reduced resolvent maps $\mathbb{C}_- \ni z \mapsto (P_e^\perp L P_e^\perp - z)^{-1} \restriction_{\text{Ran } P_e^\perp}$ are sufficiently regular for $\text{Re } z$ close to e (Limiting Absorption Principle), we show the following result in [2].

$\exists c > 0$ s.t. for $0 < |\Delta| < c$ and all $t > 0$, we have, weakly on a dense set of vectors in \mathcal{H} ,

$$\begin{aligned} e^{itL} = & \sum_{\substack{\text{partially} \\ \text{stable}}} \left\{ e^{itE_e} \Pi_{E_e} + \sum_{j=1}^{m_e-1} e^{it(e+\Delta^2 a_{e,j})} \Pi'_{e,j} \right\} \\ & + \sum_{\substack{\text{unstable} \\ e}} \sum_{j=0}^{m_e-1} e^{it(e+\Delta^2 a_{e,j})} \Pi'_{e,j} + O(1/t) \end{aligned} \quad (3)$$

Here, Π_{E_e} is the spectral projection of L associated to the eigenvalue E_e . The exponents satisfy $a_{e,j} = \lambda_{e,j} + O(\Delta)$ with $\text{Im } \lambda_{e,j} > 0$ (implying time decay) and $\Pi'_{e,j} = P_{e,j} + O(\Delta)$ are projection operators (decay directions). The first sum shows oscillatory parts $\propto e^{itE_e}$ of the surviving partially stable eigenvalues and decaying parts due to the loss of multiplicity, while the second sum, associated to unstable eigenvalues, is purely decaying. The Δ independent $\lambda_{e,j}$ and $P_{e,j}$ can be calculated by perturbation theory. The decaying exponentials stay sizable for long times $t \lesssim (\Delta^2 \text{Im } \lambda_{e,j})^{-1}$ over which the $O(1/t)$ remainder is subdominant (t not too small).

Application to transfer processes. The expansion (3) can be used to analyze the time evolution of the donor probability $p_D(t)$, (1), in the setting $\lambda \gg \Delta$ encountered in biological applications. We find [6]

$$p_D(t) = p_\infty + e^{-\gamma t} (p(0) - p_\infty) + O(1/t) \quad (4)$$

Here p_∞ is the asymptotic (renormalized by strong interaction) thermal equilibrium value and

$$\begin{aligned} \gamma = & \Delta^2 \lim_{r \rightarrow 0+} \int_0^\infty e^{-rt} \cos(\epsilon t) \\ & \cos(\lambda^2 Q_1(t)) e^{-\lambda^2 Q_2(t)} dt + O(\Delta^4) \end{aligned} \quad (5)$$

where ϵ is the (renormalized) D - A energy difference and the $Q_{1,2}(t)$ are quantities depending only on the quantum field (spectral density function, temperature). The result (4), (5) is valid for Δ small enough but for all $\lambda \in \mathbb{R}$, $t > 0$. In the high temperature regime $T \gg \hbar\omega_c$ (a cutoff frequency) the relaxation rate γ becomes (to leading order)

$$\gamma_M = \left(\frac{\Delta}{2} \right)^2 \sqrt{\frac{\pi}{T\epsilon_r}} e^{-\frac{(\epsilon-\epsilon_r)^2}{4T\epsilon_r}} \quad (6)$$

where ϵ_r is an (explicit) constant, called the reorganization energy. Relation (6) is the famous *Marcus formula* for the transition rate. We now have a proof of the Marcus formula.² Of course, the expansion (3) can be used to analyze any D - A observable (and even reservoir observables), not just the donor probability. The current setup also allows for various generalizations of the model which alter the speed and efficiency of the reaction, as discussed in [6].

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² This is the only proof we are aware of and it assumes a suitable infrared and ultraviolet behaviour of the coupling functions. Marcus' arguments are heuristic and so is the Fermi Golden Rule type calculation for γ given by Leggett and collaborators [3].

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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Trivia, Tradition, Truth: Playfair's Axiom

Amy Ackerberg-Hastings, Independent Scholar

Which of the following is Playfair's Axiom, a statement that often appears in English-language books of elementary and popular geometry as an alternative to Euclid's Parallel Postulate?

- A) Two straight lines cannot be drawn through the same point, parallel to the same straight line, without coinciding with one another.
- B) Two straight lines, which intersect one another, cannot be both parallel to the same straight line.
- C) Through a given point only one straight line can be drawn parallel to a given straight line.

I suspect that most North American readers would respond C), but in fact the answer is D) All of the above. John Playfair, who was then Joint Professor of Mathematics at the University of Edinburgh, used A) as a substitute for the Parallel Postulate (which his predecessor, Robert Simson, had moved into the axioms in [8]) in the 1795 first edition of his textbook, *Elements of Geometry* [5]. He replaced A) with B) in the book's 1804 second edition [6]. By the turn of the 20th century, the use of the term "Playfair's Axiom" as a name for C) had taken hold, although Playfair never published that statement in his textbook.

Statements named for people who did not say them are nothing new—indeed, we have a term for the phenomenon, "Stigler's Law of Eponymy" (which Stigler based upon ideas he learned from Robert K. Merton's *Sociology of Science* [9])—but Playfair's Axiom is an especially convoluted instance of misnaming in mathematics. Playfair was not the inventor of A) or B), although he did not get around to saying so until the endnotes to the 1814 fourth edition of *Elements of Geometry* [7], where he attributed B) to William Ludlam's 1785 *The Rudiments of Mathematics* [3]. Meanwhile, not only does C) have murky origins, but also it is not logically equivalent to A) or B). C) asserts both the existence and uniqueness of parallel lines, but A) and B) posit only uniqueness.

It is relatively easy to see how A) and B) likely became known as "Playfair's Axiom." *Elements of Geometry* was a widely used

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:

Amy Ackerberg-Hastings, Chercheuse indépendante

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

textbook, including 13 printings in Great Britain and 33 printings in the United States between 1790 and 1875. Other editors and compilers also used Playfair's book, a reworking of Simson's edition of Euclid's *Elements*, as a basis for their own texts. So, thousands of undergraduate students associated their study of elementary plane and solid geometry with Playfair. Indeed, one of the questions in an annual examination administered in May 1830 at Queen's College, Cambridge, directed the examinees to

Apply Playfair's axiom, "Two straight lines which intersect one another, cannot be both parallel to the same straight line," to prove Prop. 29, Book I. "If a straight line fall upon two parallel straight lines, it makes the alternate angles equal to one another; and the exterior angle equal to the interior and opposite upon the same side; and likewise the two interior angles upon the same side together equal to two right angles." [9, p. 31]

Bibliographic searches of books and journals in their print or digitized forms suggest that the pairing of the term "Playfair's axiom" with statement B) gradually became commonplace after 1830. Meanwhile, as had been the case since antiquity, other attempts to correct the shortcomings of the Parallel Postulate circulated. As college and school textbooks also proliferated, these alternatives began to appear in educational materials as well as in formal treatises. For instance, C) appeared as a corollary in the entry for "Parallel" in William Nicholson's 1809 *British Encyclopedia* [4, vol. 5] and was promoted to an axiom in the American Edward Brooks's 1865 *Normal Elementary Geometry* [1].

At present, Arthur Buchheim seems to have been the first to associate C) with Playfair, in an 1878 paper for his alma mater's magazine:

To obviate this difficulty [that the truth of the parallel postulate is not obvious], different axioms have been proposed by some writers on geometry, while others have attempted to establish a theory of parallels without any axioms; on all these attempts I need only remark that they have all been found unsatisfactory. The only axiom I shall notice is that given by Playfair and many subsequent writers: "Through a given point only one straight line can be drawn parallel to a given straight line." [2, pp. 78–79]

Buchheim was involved in the English movement to reform geometry teaching, which raises the question why he did not know

that Playfair in fact had not “given” C), but which also suggests why he favored this axiom. Because C) allows for existence as well as uniqueness, it was compatible with projective geometry and paved the way for thinking about non-Euclidean geometry, which the reformers wanted added to the school curriculum. By the turn of the 20th century, C) was consistently labeled as “Playfair’s Axiom” in British and North American textbooks.

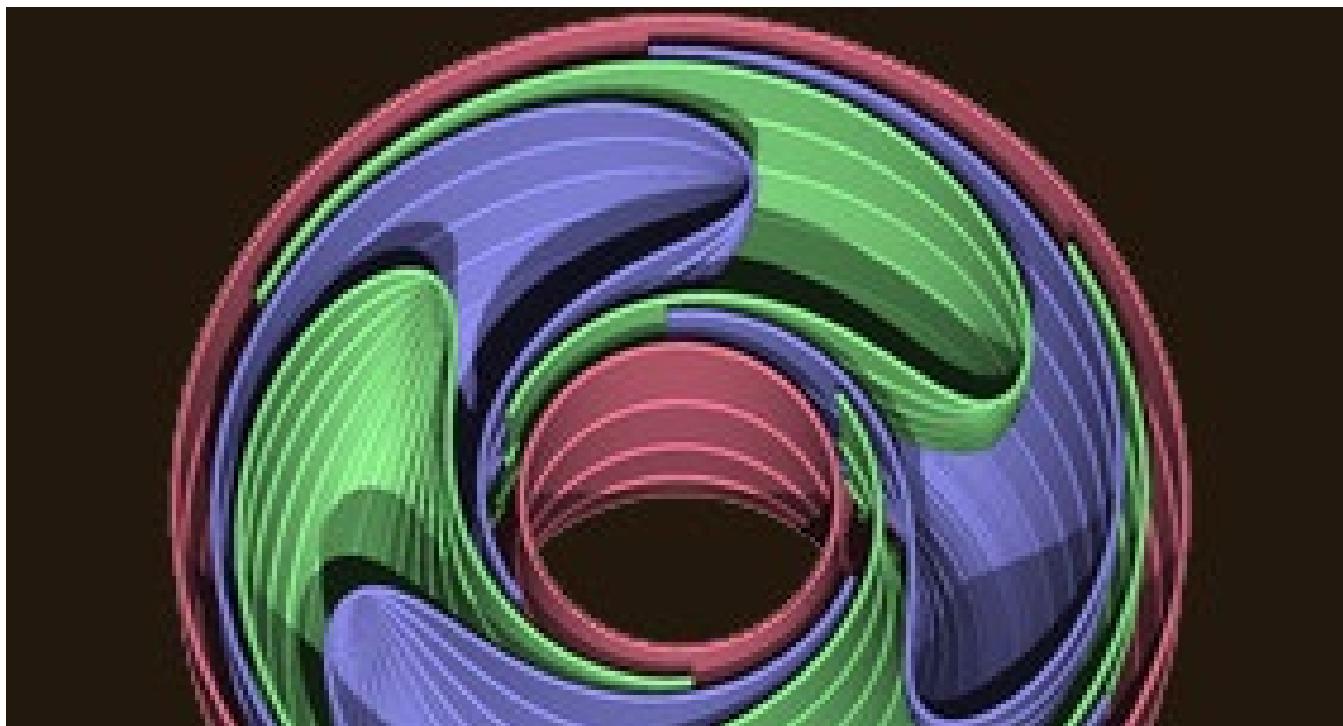
I have been trying intermittently for over a decade to sort out how Playfair’s name became attached to C); I am not the first researcher to make such an attempt, and I doubt I will be the last. In part because the body of 19th-century printed literature is so vast and an earlier usage can always turn up, the “truth” is elusive. Other historians have asked me about the purpose of this search for at least two valid reasons: (1) Trying to find the origin of “Playfair’s Axiom” *only* to be able to say that such-and-such mention is the first one results in the answer to a trivia question, not better historical understanding; (2) While most English-speaking mathematicians have heard the term “Playfair’s Axiom”, it is not commonly used in education in non-English-speaking countries.

My response is that making sense of this whole story reveals valuable context for the history of mathematics education. We have seen here how quickly scattered appearances of a label can coalesce into a tradition, and then how the tradition can lose touch with its origin. In other words, the names and statements we see in textbooks and teaching each have backstories that provide insight into particular cultures. The twists and turns in the tale of Playfair’s axiom thus tell us about changing priorities in British and American mathematics teaching, including the growth of written testing in the middle third of the 19th century and the effort to dislodge Euclid from his millennia of dominance in the last third of that century. Even with seemingly routine material, educators, mathematicians, and historians always need to pay attention and think critically.

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- Amy Ackerberg-Hastings (aackerbe@verizon.net) edits the Bulletin, CSHPM’s semiannual newsletter. She has spent so much intellectual time with John Playfair since the late 1990s that he sometimes serves as her Facebook avatar. An expanded version of this column appeared in Research in History and Philosophy of Mathematics: The CSHPM 2016 Annual Meeting in Calgary (Birkhäuser, 2018).*





André Lichnerowicz Prize in Poisson geometry – 2018

The André Lichnerowicz Prize in Poisson geometry was established in 2008. It is awarded for notable contributions to Poisson geometry, every two years at the *International Conference on Poisson Geometry in Mathematics and Physics*, to researchers who completed their doctorates at most eight years before the year of the Conference.

The prize is named in memory of André Lichnerowicz (1915–1998) whose work was fundamental in establishing Poisson geometry as a branch of mathematics. It is awarded by a jury composed of the members of the scientific/advisory committee of the conference.

The prize for the year 2018 was awarded to:

Brent Pym and Chelsea Walton

on July 16, 2018 at the Fields Institute, Toronto

Brent Pym received his Ph.D. at the University of Toronto in 2013, under the direction of Marco Gualtieri. He has held postdoctoral positions at McGill, Oxford, and Edinburgh, and recently accepted an assistant professorship in the Department of Mathematics and Statistics at McGill University. In his thesis work, Pym classified the noncommutative deformations of complex projective 3-space, proved the 4-dimensional case of the Bondal conjecture about Fano Poisson manifolds, and jointly with Gualtieri and Li, developed the theory of the Stokes groupoids on Riemann surfaces. In recent work, Pym developed the notion of an elliptic singularity for a holomorphic Poisson structure and used it to obtain some of the only available classification results in dimension greater than three. He has also developed the notion of a holonomic Poisson manifold (joint with Schedler), bringing the theory of perverse sheaves into

the mainstream of Poisson geometry. In additional joint works, Pym has contributed to the enumerative geometry of noncommutative spaces, and to the theory of Dirac structures and Courant algebroids as objects in shifted symplectic geometry.

Chelsea Walton completed her Ph.D. in 2011 at the University of Michigan, under the direction of Toby Stafford and Karen Smith. Following postdoctoral stays at the University of Washington, at MSRI, and at MIT, she took on an assistant professorship at Temple University in Philadelphia in 2015. In July 2018, she joined the Mathematics Department at the University of Illinois at Urbana-Champaign at the rank of associate professor with tenure. Walton has written several important works in Poisson Geometry, in addition to being a well-established expert in Noncommutative algebra and Quantum groups. Her work in Poisson Geometry includes a deep investigation of the 3-D and 4-D Sklyanin algebras, especially those that are module-finite over their center. Joint with Wang and Yakimov, Walton showed that these are close analogues of Poisson algebras, namely Poisson Z-orders, which carry Poisson structures on the center. Walton, in joint work with several collaborators, has written a deep series of works on actions of Hopf algebras on commutative and noncommutative domains, showing that semisimple Hopf actions generally factor through group algebra actions, and also investigating the difficult non-semisimple case. She also gave a negative answer to the long-standing conjecture about whether the universal enveloping algebra of the Witt algebra is noetherian (joint with Sierra).

Call for Proposals: 2019 CMS Math Competition Grants

The CMS is now accepting applications for the 2019 CMS Math Competition Grants program. The CMS supports activities that promote the learning of mathematics among Canadian youth. In addition to the Society's math competitions, the CMS offers math competition grants for activities at the elementary and secondary school levels.

The deadline for submissions is **November 15, 2018**. Successful applicants will be informed in January 2019 and the grants issued in February 2019.

Further details about the math competitions grants and the application process are available on the CMS website: <https://cms.math.ca/Competitions/grants>

The Committee on Grants for Provincial Competitions (CGPC) adjudicates proposals for support. Should you have further questions or comments, please contact the Committee by e-mail at chair-grants-pc@cms.math.ca

Applications should be submitted electronically, preferably in PDF format, **no later than November 15, 2018** to mathgrants@cms.math.ca.

Appel de projets : Subventions pour les concours mathématiques de la SMC 2019

La SMC accepte maintenant des demandes de subventions pour le programme des concours de mathématiques de la SMC 2019. La SMC appuie des activités qui favorisent l'apprentissage des mathématiques chez les jeunes canadiens. En plus d'organiser ses propres concours de mathématiques, la SMC offre des subventions pour les concours de mathématiques pour les activités scolaires au niveau primaire et secondaire.

La date limite pour présenter sa demande est **le 15 novembre 2018**. Les projets retenus seront annoncés en janvier 2019, et les bourses distribuées en février 2019.

Pour vous procurer un formulaire ou pour de plus amples renseignements sur l'appel de projets, passez sur le site de la SMC au : <https://cms.math.ca/Concours/grants>

Le Comité du financement des concours provinciaux (CFCP) évalue la répartition des bourses. Pour toute question ou tout commentaire sur le financement des concours provinciaux, veuillez communiquer par courriel avec le comité à pres-grants-pc@smc.math.ca

Les demandes devraient être présentées par voie électronique, préféablement en format PDF, **au plus tard le 15 novembre 2018**, à l'adresse suivante : subventionsmaths@smc.math.ca



2019 Canadian Mathematical Society
Summer Meeting

June 7 - 10, 2019

Deadline: January 15, 2019

University of Regina, Regina, Saskatchewan

CALL FOR SESSIONS

The Canadian Mathematical Society (CMS) welcomes and invites session proposals for the 2019 CMS Summer Meeting in Regina from June 7 to 10, 2019.

Proposals should include (1) names, affiliations, and contact information for all session co-organizers, (2) title and brief description of the focus and objectives of the session, (3) a preliminary list of potential speakers, with their affiliations and if they have agreed to participate, along with a total number of expected speakers.

Sessions will take place June 8, 9, or 10. The meeting schedule will accommodate 9 speakers per full day, and 4 or 5 per half day. 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.

Proposals should be submitted by January 15, 2019.

Scientific Directors:

Allen Herman (University of Regina)
allen.herman@uregina.ca

Alexander Litvak (University of Alberta)
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Karen Meagher (University of Regina)
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Réunion d'été de la SMC 2019

7 - 10 juin 2019

Date limite : 15 janvier 2019

Université de Regina, Regina, Saskatchewan

APPEL DE PROPOSITIONS DE SESSIONS

La Société mathématique du Canada (SMC) invite la communauté mathématique à proposer des sessions pour sa Réunion d'été 2019, qui se tiendra à Regina du 7 au 10 juin.

Ces propositions doivent comprendre : 1) le nom, l'affiliation et les personnes à contacter pour tous les coorganisateurs de session; 2) le titre et une brève description de l'orientation et des objectifs de la session; 3) une liste préliminaire de conférenciers potentiels, avec leur affiliation et leur intention de participer, ainsi que le nombre de conférenciers prévus.

Les sessions se dérouleront les 8, 9 et 10 juin. Le format de la Réunion peut accommoder 9 conférenciers par journée pleine, et 4 ou 5 par demi-journée. 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 l'un des directeurs scientifiques.

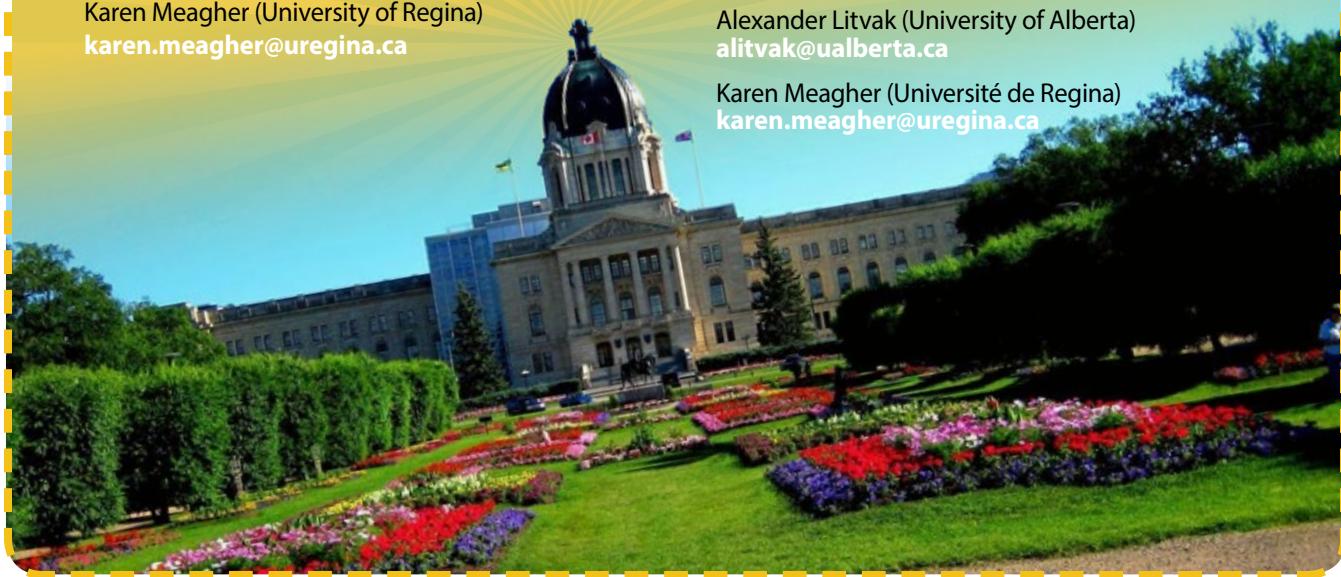
Ces demandes doivent nous parvenir au plus tard le 15 janvier 2019.

Directeurs scientifiques :

Allen Herman (Université de Regina)
allen.herman@uregina.ca

Alexander Litvak (University of Alberta)
alitvak@ualberta.ca

Karen Meagher (Université de Regina)
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Call for Nominations 2019 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. CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity or sexual orientation. The deadline for the receipt of nominations is **January 31, 2019**.

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.

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity or sexual orientation.

All documentation, including letters of recommendation, should be submitted electronically, preferably in PDF format, no later than **January 31, 2019**, to docprize@cms.math.ca.

Appel de mises en candidature Prix de doctorat 2019

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. La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs de département et les comités de mise en candidature à proposer des collègues exceptionnels sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle. Les candidatures doivent parvenir à la SMC au plus tard le **31 janvier 2019**.

Le dossier sera constitué des documents suivants :

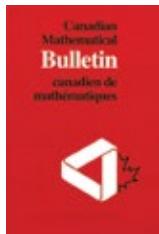
- Un curriculum vitae rédigé par l'étudiant.
- Un résumé du travail du candidat d'au plus dix pages, rédigé par l'étudiant, où celui-ci décrira brièvement sa thèse et en expliquera l'importance, et énumérera toutes ses autres réalisations pendant ses études de doctorat.
- Trois lettres de recommandation, 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.

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs de département et les comités de mise en candidature à proposer des collègues exceptionnels sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle.

Veuillez faire parvenir tous les documents par voie électronique, de préférence en format PDF, au plus tard le **31 janvier 2019** à prixdoc@smc.math.ca.

CANADIAN MATHEMATICAL BULLETIN (CMB)

EDITOR-IN-CHIEF (EIC)



The CMS invites expressions of interest for the Editor-In-Chief (EIC) of CMB; two EICs are being solicited, with a term scheduled to commence January 1, 2020. Funding support from the CMS is available for both these EIC positions.

Since 1958, the Canadian Mathematical Bulletin (CMB) has been committed to publishing original mathematical research of high standard following rigorous academic peer review. New research papers are published continuously online and collated into print issues four times each year.

Expressions of interest should include a covering letter indicating the type of editorships you are interested in or becoming involved with, your curriculum vitae, and an expression of views regarding the publication. For EIC consideration, please also include an indication of support from your respective university.

Please submit your expression of interest electronically to: CMB-EIC-2019@cms.math.ca before April 15, 2019.

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BULLETIN CANADIEN DE MATHÉMATIQUES (BCM)

RÉDACTEUR EN CHEF

La SMC invite les personnes intéressées par un poste de rédacteur en chef au BCM à lui faire part de leur intérêt. Deux postes de rédacteurs en chef sont à pourvoir, pour un mandat qui commencera en le 1 janvier 2020. La SMC offre du soutien financier pour ces deux postes.

Depuis 1958, le Bulletin canadien de mathématiques s'engage à publier des recherches en mathématiques, originales et de haut niveau, suivant de rigoureux examens par des pairs. Les articles de recherches sont disponibles en tout temps en ligne et sont rassemblés en quatre éditions imprimées par année.

Les propositions de candidature comprendront les éléments suivants : une lettre de présentation précisant le type de poste qui vous intéresse, votre curriculum vitae et un texte dans lequel vous exprimez votre opinion et vos idées par rapport à la publication. Pour les postes de rédacteur en chef, veuillez ajouter une preuve du soutien de votre université.

Veuillez faire parvenir votre candidature par courriel à : BCM-REC-2019@smc.math.ca au plus tard le 15 avril 2019.

Conseil de redaction pour le JCM et le BCM à présent :

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Ailana Fraser (UBC Vancouver)	12/2020	Rédactrice associée
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Wee Teck Gan (National University of Singapore)	12/2021	Rédacteur associé
Dragos Ghioca (UBC Vancouver)	12/2018	Rédacteur associé
Philippe Gille (CNRS & Université Claude Bernard)	12/2021	Rédacteur associé
Vojkan Jaksic (McGill)	12/2021	Rédacteur associé
Lisa Jeffrey (Toronto)	12/2021	Rédactrice associée
Javad Mashreghi (Laval)	12/2020	Rédacteur associé
Marco Merkli (Memorial)	12/2020	Rédacteur associé
Assaf Naor (Princeton)	12/2018	Rédacteur associé
Nilima Nigam (Simon Fraser)	12/2020	Rédactrice associée
Alistair Savage (Ottawa)	12/2021	Rédacteur associé
Juncheng Wei (UBC Vancouver)	12/2018	Rédacteur associé
Daniel Wise (McGill)	12/2018	Rédacteur associé

2019 Excellence in Teaching Award

The CMS Excellence in Teaching Award Selection Committee invites nominations for the **2019 Excellence in Teaching Award**.

The Excellence in Teaching Award focuses on the recipient's proven excellence as a teacher at the undergraduate level, including at universities, colleges and cégeps, as exemplified by unusual effectiveness in the classroom and/or commitment and dedication to teaching and to students. The dossier should provide evidence of the effectiveness and impact of the nominee's teaching. The prize recognizes sustained and distinguished contributions in teaching at the post-secondary undergraduate level at a Canadian institution. Only full-time teachers or professors who have been at their institution for at least five years will be considered. The nomination will remain active for three years, with a possibility to update.

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

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity or sexual orientation.

Nominations and reference letters should be submitted electronically, preferably in PDF format, to: etaward@cms.math.ca no later than the deadline of **November 15, 2018**.

Prix d'excellence en enseignement 2019

Le Comité de sélection du Prix d'excellence en enseignement de la SMC sollicite des mises en candidature pour le **Prix d'excellence en enseignement 2019**.

Le Prix d'excellence en enseignement de la SMC récompense l'excellence reconnue d'un enseignant ou d'un professeur de niveau postsecondaire (universités, collèges et cégeps), telle qu'illustrée par son efficacité exceptionnelle en classe et/ou son engagement et son dévouement envers l'enseignement et les étudiants. Le dossier de candidature doit montrer l'efficacité et les effets de l'enseignement du candidat ou de la candidate. Ce prix récompense des contributions exceptionnelles et soutenues en enseignement collégial et de premier cycle universitaire dans un établissement canadien. Seules les candidatures d'enseignants et de professeurs à temps plein qui travaillent dans le même établissement depuis au moins cinq ans seront retenues. Une candidature peut être mise à jour et demeure active pendant 3 ans.

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

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs de département et les comités de mise en candidature à proposer des collègues exceptionnels sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, à : prixee@smc.math.ca avant la date limite du **15 novembre 2018**.



A Taste of Mathematics (ATOM)

EDITOR-IN-CHIEF

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 November 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

Current ATOM Editorial Board

Kseniya Garaschuk (Fraser Valley), Associate Editor to 12/2020

Frédéric Gourdeau (Laval), Associate Editor to 8/2019

Miroslav Lovric (McMaster), Associate Editor to 12/2020

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

Denise Charron (CMS), Managing Editor

Aime-T-On les Mathématiques (ATOM)

RÉDACTEUR-EN-CHEF

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 novembre 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

Conseil de rédaction ATOM à présent

Kseniya Garaschuk (Fraser Valley),
Rédactrice associée à 12/2020

Frédéric Gourdeau (Laval), Rédacteur associé à 8/2019

Miroslav Lovric (McMaster), Rédacteur associé à 12/2020

Jamie Mulholland (Simon Fraser), Rédacteur associé à 12/2020

Denise Charron (CMS), Rédactrice-gérante

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