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DANS CE NUMÉRO

Canadian Mathematical Society
Société mathématique du Canada

CMS NOTES de la SMC

December/décembre 2014

Vice-President Notes

Gregory G. Smith, *CMS Vice-President—Ontario*

The CMS website includes the sentence "The Canadian Mathematical Society promotes the advancement, discovery, learning and application of mathematics in Canada." As a mission statement, it has the benefits of being both clear and concise. Although there are members of the CMS who would like something more specific or inspirational, I am unaware of anyone who literally disagrees with this sentence. The ongoing challenge is figure out how to accomplish this goal. Given the inherent limits on volunteer's time and financial resources, we must prioritize among the many endeavours that promote and advance mathematics. We should also regularly re-evaluate our choices and look for new opportunities. With this in mind, how should the CMS change over the next ten years?

A national society, such as the CMS, is needed to represent the Canadian mathematical community to various international and domestic bodies. For example, the CMS is a full member of International Council for Industrial and Applied Mathematics (ICIAM) and Mathematical Congress of the Americas (MCA). In conjunction with National Research Council of Canada (NRC), the CMS also represents Canada at the International Mathematical Union (IMU). The CMS trains and coaches Math Team Canada to compete at the International Mathematical Olympiad (IMO). On the domestic stage, the CMS advocates for mathematics. Sometimes this takes the form of quiet bilateral meetings with the Natural Sciences and Engineering Research Council (NSERC) and other times it involves working with the Statistical Society of Canada (SSC) to convince Statistics Canada to preserve its educational outreach materials. By providing secretarial and logistic support, the CMS also aids the annual meeting of Chairs and Heads of Canadian Mathematics Departments. If the CMS did not exist, then we would need to create a similar organization just to do this important work. Choosing to engage in these particular activities is rather easy because they require relatively few resources. However, our ability to successfully undertake many of them does depend on the CMS credibly representing Canadian mathematical community. Somewhat paradoxically, I don't think these projects actually inspire people to join the CMS. How can we increase our membership?

From my perspective, the conferences organized by the CMS are the most prominent ventures. The semi-annual meetings highlight the latest mathematical developments from across Canada and around the world. The CMS awards and prizes presented at these meetings celebrate excellence within the Canadian mathematical community. Should we be looking for additional ways to recognize Canadian mathematical talent? Because the CMS handles almost all of the technical details, the organizers of the sessions are able to concentrate on the scientific content. In my experience, most people attend a CMS conference for one peculiar session. I know some areas of mathematics in which leaders make an effort to ensure that their field is regularly showcased at these national conferences. How do we encourage similar leadership from more branches of mathematics? Some people have the impression that organizers

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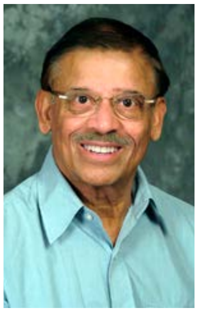
Thoughts on Lecturing



Srinivasa Swaminathan, *Dalhousie University, Halifax, NS*

"A professor's lecture notes go straight to the students' lecture notes, without passing through the brains of either." This is part of a quotation attributed to Mark Twain, perhaps erroneously. It is true that the attention span of most students is limited. They listen to several lectures during the day and spend most of the time writing down 'notes'. On a given day, their interests are focused on assignments which are due that day or the next. In view of all this it is a problem for a professor to get the students to take a sustained interest in his (her) lecture.

One of the successful methods in this direction is to start a lecture by telling a story. It does not matter whether the story is relevant to the lecture topic of the day. For example, I have used the following story: it concerns the invention of the sewing machine. Elias Howe, an American inventor who lived in first half of the 19th century spent years trying to figure out how he could get the sewing needle through the cloth repetitively without having to turn the needle around. He had been trying to solve this problem unsuccessfully for many years. One night, he had a nightmare in which he dreamt that he had been captured by savages. Their leader noted the needle and thread in Elias's hand and heard about his problem concerning this. He decreed that Elias must come up with a solution to this problem within 24 hours, failing which he will be put to death. Unfortunately, even in the dream, Elias was unable to think calmly and thus, could not come up with a solution within the allotted time. At the end he saw the frenzied savage mob approaching him with huge spears rising and falling. This spectacle made him realize that all of the spears had eye-shaped holes in the tips. He awoke with the revelation that the needle for his sewing machine should be threaded at the tip, the sharp pointed end, not in the middle or at the tail, as was usual for ordinary sewing needles! The new sewing machine was born.

Stories like this enliven the interest of students; they get into a better mood to follow closely the subsequent lecture. A story with some humor will also help. For example: A motorist was 100 yards from an open railway level crossing, proceeding at 50 m.p.h. A train was approaching at 60 m.p.h. and was 35 ft away from the railway crossing.

Question: Did the motorist get across? Answer: Yes, he got a cross. His wife bought it out of his insurance.

Réflexions sur les exposés magistraux

« Les notes de cours du professeur passent aux notes de cours de l'étudiant, sans passer par le cerveau ni de l'un ni de l'autre ». Voilà un bout d'une citation attribuée à Mark Twain, peut-être par erreur. Il est vrai que la durée d'attention de la plupart des étudiants est limitée. Les étudiants écoutent plusieurs exposés pendant la journée et passent le plus clair de leur temps à prendre des « notes ». Dans une journée typique, leur attention est portée aux travaux à remettre le jour même ou le lendemain. Dans ces circonstances, le professeur a peine à retenir l'attention soutenue des étudiants pendant qu'il ou elle donne son exposé.

Une des méthodes qui donnent de bons résultats à ce chapitre consiste à entamer l'exposé en relatant une anecdote ou une histoire. Il importe peu que l'histoire soit liée au sujet de l'exposé ce jour-là. Par exemple, j'ai déjà raconté l'histoire suivante (elle porte sur l'invention de la machine à coudre) : Elias Howe, inventeur américain qui a vécu au cours de la première moitié du 19e siècle, a consacré des années à la recherche d'un moyen d'enfiler une aiguille à coudre dans du tissu de façon répétée sans la retourner. Il tentait en vain de régler ce problème depuis de nombreuses années. Un soir, il a fait un cauchemar. Il s'était vu capturer par des sauvages. Leur chef avait remarqué l'aiguille et le fil dans sa main et avait eu vent de son problème. Le chef a ensuite déclaré qu'Elias devait trouver une solution à ce problème en moins de 24 heures, sans quoi il serait mis à mort. Malheureusement, même au pays des rêves, Elias ne pouvait pas réfléchir calmement et, par conséquent, n'arrivait pas à trouver une solution dans le délai accordé. À la fin de son rêve, il voyait de nombreux sauvages s'approchant de lui, lances à la main. Les lances étaient brandies de haut en bas. Devant ce spectacle, Elias remarque que toutes les lances étaient trouées au bout et que ces trous avaient la forme d'un œil. Au réveil, c'est la révélation : le trou de l'aiguille de sa machine à coudre devait être pratiqué dans la pointe, le bout pointu et coupant, et non pas au milieu ou dans la queue, comme pour les aiguilles à coudre ordinaires! La nouvelle machine à coudre venait de voir le jour.

Les anecdotes de la sorte suscitent l'intérêt des étudiants; leur humeur s'améliore et les aide à écouter attentivement l'exposé qui suit. Une anecdote humoristique fera aussi l'affaire. Par exemple : trois étudiants doivent faire un examen final le lundi. Ils sont brillants et vont faire la fête le dimanche. Ne s'étant pas réveillés le lundi matin, les trois ratent l'examen et se présentent dans le bureau du professeur responsable pour présenter leurs excuses. Ils lui demandent de reprendre l'examen en prétextant avoir fait une crevaison en route vers l'examen. Le professeur accepte, les place dans des salles différentes et leur donne les sujets d'examen. Le premier problème est noté sur 5 points. Chacun le lit dans son coin et trouve le problème très facile. Ils tournent la page. Le second problème vaut 95 points : quelle roue a crevé?

Notes du vice-président

Gregory G. Smith, *vice-président SMC – Ontario*

Dans le site web de la Société mathématique du Canada (SMC), on peut lire que la Société « s'est donnée pour objectif de promouvoir et de favoriser la découverte et l'apprentissage des mathématiques, et les applications qui en découlent ». Cet énoncé de mission a le mérite d'être à la fois clair et concis. Bien que certains membres de la SMC préféreraient un énoncé empreint d'une inspiration et d'une précision accrues, je ne connais personne en total désaccord avec la phrase. Trouver comment réaliser cet objectif est le défi que nous devons relever continuellement. Étant donné les limites inhérentes à nos ressources financières et au temps que peuvent nous donner nos bénévoles, nous devons faire des choix quant à la priorité à donner aux nombreuses initiatives de promotion et d'avancement des mathématiques. Nous devrions aussi réévaluer régulièrement ces choix et rester à l'affût des nouvelles occasions. C'est en ayant ces questions à l'esprit que j'aimerais vous demander comment vous voyez l'évolution la SMC au cours des dix prochaines années.

La communauté mathématique canadienne doit être représentée par un organisme d'envergure nationale, comme la SMC, auprès de divers organismes nationaux et internationaux. À titre d'exemple, la SMC est membre à part entière de l'International Council for Industrial and Applied Mathematics (ICIAM) et du Congrès mathématique des Amériques (CMA). De concert avec le Conseil national de recherche Canada (CNRC), la SMC représente aussi le Canada à l'Union mathématique internationale (UMI). La SMC entraîne et encadre Équipe Math Canada pour de l'Olympiade internationale de mathématiques (OIM). À l'échelle nationale, la SMC souligne l'importance des mathématiques en participant, par exemple, à de simples réunions bilatérales avec le Conseil de recherches en sciences naturelles et en génie (CRSNG) ou en collaborant avec la Société statistique du Canada (SSC) pour convaincre Statistique Canada de préserver son matériel didactique de sensibilisation. En fournissant un appui logistique et administratif, la SMC vient aussi en aide à l'assemblée annuelle des directeurs et chefs des départements canadiens de mathématiques. Si la SMC n'existait pas, il faudrait créer un organisme semblable uniquement dans le but d'accomplir ce travail important. S'engager dans ces activités particulières est plutôt facile, car elles n'exigent que relativement peu de ressources. Cela étant dit, notre capacité à mener à bien nombre de ces initiatives dépend de la crédibilité de la SMC dans sa représentation de la communauté canadienne des mathématiques. Assez paradoxalement, je ne suis pas d'avis que ces projets en inspirent beaucoup à adhérer à la SMC. Autrement dit, comment pourrions-nous faire croître le nombre de nos membres?

De mon point de vue, les congrès organisés par la SMC sont les événements les plus populaires de notre organisme, et les Réunions semestrielles nous permettent de présenter les avancées les plus

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Letters to the Editors

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

Lettres aux Rédacteurs

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

NOTES DE LA SMC

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

CMS NOTES

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

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récentes en mathématiques réalisées au Canada et dans le monde. Les prix remis à ces Réunions célèbrent l'excellence au sein de notre communauté au Canada. Devrions-nous trouver d'autres façons de souligner nos talents canadiens? Les organisateurs de ces événements ont le loisir de se concentrer sur le contenu scientifique puisque la SMC s'occupe de presque tous les détails techniques. D'après mon expérience, je peux dire que la plupart des personnes qui assistent à un congrès de la SMC le font pour une séance en particulier. Je sais que certains chefs de file font des efforts pour que leur sous-domaine soit régulièrement représenté à ces événements nationaux. Comment pourrions-nous encourager les responsables d'autres sous-domaines à en faire autant? Certains estiment que les organisateurs devraient entretenir une forme de lien géographique avec le lieu où se tient la Réunion. Comment changer cette perception? Le plus souvent, si je comprends bien, les Réunions d'hiver sont financièrement autonomes, mais les Réunions d'été entraînent un déficit. Les Réunions d'été sont-elles assez importantes pour que les autres unités de la Société les financent? Je présume que non. Et si c'est exact, nous devons restructurer les Réunions d'été. Serait-il plausible de remplacer les Réunions nationales d'été par des Réunions ou des ateliers régionaux?

L'autre initiative la plus notable de la SMC est la publication de ses revues scientifiques : le *Journal canadien de mathématiques* (JCM) et le *Bulletin canadien de mathématiques* (BCM) sont deux revues bien établies. Bien que sensibles aux fluctuations des taux de change, ces deux publications se portent bien financièrement pour le moment, je pense. Il n'empêche que les nombreux changements dans le milieu de l'édition scientifique, notamment les initiatives à code source libre et les accès groupés aux revues, font que nous devrons peut-être faire preuve d'une proactivité accrue très bientôt à cet égard. Devrions-nous lancer de nouvelles revues? Devrions-nous tenter de rehausser considérablement le prestige ou l'importance de nos revues actuelles? Devrions-nous nous joindre à un groupe plus vaste de revues, en créer un ou suivre les mêmes orientations d'un tel groupe? Bref, où souhaitons-nous positionner la SMC dans le domaine de l'édition en constante évolution?

La SMC offre aussi de nombreux programmes éducatifs. Concevoir des programmes qui sauront à la fois attirer le plus grand nombre et dénicher les participants les plus doués est le défi que nous devons constamment relever pour les concours mathématiques. Les divers camps mathématiques financés par la SMC sont sans contredit très bénéfiques pour les élèves qui y participent, et la SMC organise périodiquement un Forum national sur l'enseignement. À quelle hauteur la contribution de la SMC à ces partenariats et initiatives peut-elle et devrait-elle se situer? Quelles nouvelles initiatives la SMC devrait-elle lancer?

Continued from cover

should have a geographical connection to the meeting. How do we change this perception? As I understand it, the winter meetings are normally financially self-sufficient. In contrast, the summer meetings typically run a deficit. Are the summer meetings important enough to be subsidized by other parts of the society? I would guess not. If this guess is correct, then we need to look for ways to restructure the summer meetings. Would it make sense to replace the summer national meeting with regional meetings or workshops?

The second conspicuous enterprise associated with the CMS are its scholarly journals. The Canadian Journal of Mathematics (CJM) and Canadian Mathematical Bulletin (CMB) are both solid research journals. Although susceptibly to changes in the exchange rate, I think that both journals are currently in good a financial position. However, given the many changes in scientific publishing, including open-source initiatives and bundled access to journals, I suspect that we may need to be more proactive in the near future. Should we start new journals? Should we aim to significantly alter the stature or prestige of the existing journals? Should we join, create, or align ourselves with a larger group of journals? Where do we want the CMS to fit into the evolving publishing landscape?

The CMS also offers many educational programs. Striking the right balance between broad appeal and identifying the elite few is a continual issue for the math competitions. The various math camps supported by the CMS undoutably benefit the student participants and the CMS also periodically stages a national education forum. How much can and should the CMS contribute to these partnerships and pursuits? What new initiatives should the CMS launch?

Le calendrier des activities announce 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.

Johan Rudnick, *Société mathématique du Canada (directeur@smc.math.ca)*

Calendar Notes 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.

Johan Rudnick, *Canadian Mathematical Society, (director@cms.math.ca)*

DECEMBER 2014

1-5 NZMS/CMSA/VUW **38th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Wellington, New Zealand

5-8 CMS **Winter Meeting**, Hamilton, Ont.

10 FIELDS **Distinguished Lecture Series in Statistical Science**: Bin Yu, Toronto, Ont.

8-12 CRM **Workshop: New approaches in probabilistic and multiplicative number theory**, Montreal, Que.

15-18 CRM/CANSSI **Workshop on New Horizons in Copula Modeling**, Montreal, Que.

15-19 FIELDS/CANSSI **Conference on Analysis, Spectra, and Number Theory**, Princeton University, N.J.

JANUARY 2015

10-13 AMS/MAA **2015 Joint Mathematics Meeting**, San Antonio Convention Center, San Antonio, Texas

12-23 FIELDS/CANSSI Thematic Program on Statistical Inference, Learning and Models for Big Data, **Opening Conference and Boot Camp**, Toronto, Ont.

23-25 FIELDS **Combinatorial Algebra meets Algebraic Combinatorics**, Queen's University, Kingston, Ont.

26-30 FIELDS/CANSSI **Workshop on Big Data and Statistical Machine Learning**, Toronto, Ont.

FEBRUARY 2015

9-13 FIELDS/CANSSI **Workshop on Optimization and Matrix Methods in Big Data**, Toronto, Ont.

16-20 CRM **Workshop: Regulators, Mahler measures, and special values of L-functions**, Montreal, Que.

23-27 FIELDS/CANSSI **Workshop on Visualization for Big Data: Strategies and Principles**, Toronto, Ont.

30 PIMS/UBC **Distinguished Colloquium: Tom Hou**, University of British Columbia, B.C.

MARCH 2015

9-14 CRM **Workshop: p-adic methods in the theory of classical automorphic forms**, Montreal, Que.

13 PIMS/UBC PIMS/UBC **Distinguished Colloquium: Jill Pipher**, University of British Columbia, B.C.

23-27 FIELDS/CANSSI **Workshop on Big Data in Health Policy**, Toronto, Ont.

APRIL 2015

6-10 CRM **Workshop: The Kudla programme**, Montreal, Que.

13-17 FIELDS/CANSSI **Workshop on Big Data for Social Policy**, Toronto, Ont.

15-18 NCTM **2015 Annual Meeting and Exposition**, Boston, MA

30-M2 SIAM **International Conference on Data Mining**, Vancouver, B.C.

MAY 2015

2 SIAM Great Lakes Section **2015 Annual Conference**, Grand Rapids, MI

4-8 FIELDS Short Thematic Program: **Differential equations with variable delay**, Toronto, Ont.

6-8 FIELDS **Algorithms and Complexity in Mathematics, Epistemology and Science** (ACMES), Western University, Ont.

7-10 FIELDS **Representation Theory and Analysis on Lie Groups over Local Fields**, University of Ottawa, Ont.

11-15 FIELDS Short Thematic Program: **Delay-Differential equations in physical sciences and engineering**, Toronto, Ont.

15-17 CRM **XVIIIe colloque panquébécois des étudiants de l'Institut des Sciences Mathématiques** (ISM), Montreal, Que.

19-22 FIELDS Short Thematic Program: **Structured delay systems**, Toronto, Ont.

25-29 FIELDS Short Thematic Program: **Delay differential equations in life sciences and medicine**, Toronto, Ont.

JUNE 2015

1-4 CanaDam **5th biennial Canadian Discrete and Algorithmic Mathematics Conference**, University of Saskatchewan, Sask.

5-8 CMS **Summer Meeting**, University of Prince Edward Island, Charlottetown, P.E.I.

5-9 CMESG **2015 Meeting**, University of Moncton, Moncton, N.B.

7-12 CAIMS **2015 Annual Meeting**, Waterloo, Ont.

12-14 FIELDS **Symposium on Mathematics Education And Coding Modelling Mathematics Relationships With Code, Faculty of Education**, Western University, Ont.

13-14 FIELDS/CANSSI Thematic Program on Statistical Inference, Learning and Models for Big Data, **Closing Conference**, Toronto, Ont.

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Book Review Notes 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)*

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

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

Classification and Identification of Lie Algebras

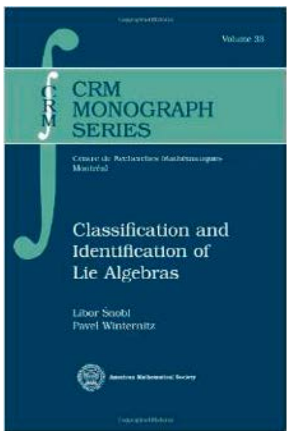
by Libor Šnobl and Pavel Winternitz

CRM Monograph Series 33

AMS, 2014

ISBN: 978-0-8218-4355-0

Reviewed by ***R. Campoamor-Stursberg****, Instituto de Matemática Interdisciplinar and Universidad Complutense de Madrid, Spain*



One problem often encountered when dealing with Lie algebras given in matrix, operator or vector field form is the identification of the underlying abstract Lie algebra and obtaining its characteristic properties. The problem can be computationally rather complicated, depending on the specific basis considered for the algebras, usually depending crucially on the nature of the problem. However, even for the expert, the precise identification of the abstract Lie algebra can be sometimes problematic, either because of the absence of a classification for higher dimensions (for the non-semisimple case) or the various different and occasionally conflicting classifications in low dimensions. While for dimensions not exceeding five the classifications of real Lie algebras are more or less uniformly established (up to some typing errors or notations), the classification problem for six dimensional real solvable Lie algebras, originating in the works of G. M. Mubarakzjanov in the early 60's, has been corrected, revised, modified and completed by different authors, resulting in a considerable number of non-equivalent lists of isomorphism classes that are often difficult to compare. A similar confusion arises when searching for the most reliable classification of nilpotent Lie algebras in dimension seven, for which there are at least five different candidates.

The present book tries to remedy this situation, presenting a concise and practical guide to the use and manipulation of finite dimensional Lie algebras appearing in a wide spectrum of applications, developing different criteria and algorithms that allow identifying the characteristic properties of arbitrary finite dimensional (real and complex) Lie algebras. In addition, the authors provide a complete revision and verification of the different classifications of real Lie algebras up to dimension six, with the objective of establishing a definitive and easily recognisable list that should prevent further confusions in the literature.

The book is divided into four parts, corresponding respectively to general features on Lie algebras, the identification of an algebra using the properties of its structure tensor, the analysis of solvable and Levi decomposable Lie algebras and the classification of real and complex Lie algebras of dimensions not exceeding six.

Part one (Chapters 1-3) contains, in condensed form, the essential facts and properties of finite dimensional Lie algebras over the fields of real and complex numbers, starting with a motivating example extracted from the Lie symmetry analysis of differential equations. The second chapter presents a short review of the main structural properties of Lie algebras. More precisely, the authors enumerate the classical criteria characterising solvable and nilpotent Lie algebras, the Killing form, the Cartan criterion for semisimplicity and the main features of the classification of simple complex Lie algebras by means of Dynkin diagrams. The results are given without proof, as the authors only intend to provide a self-contained presentation of those techniques and methods to be used in later chapters. Technical details on these results can be found in any standard texbook on Lie algebras. A paragraph is also devoted to the Chevalley-Eilenberg cohomology, a tool to be used sporadically in later sections to separate isomorphism classes of Lie algebras. In this context, the relevant cohomology spaces are those having coefficients in the trivial and adjoint modules, later on to be used for the analysis of outer derivations and extensions by derivations. The third chapter deals with the invariants (generalised Casimir invariants) of the coadjoint representation. In this framework, the two most widely used methods are reviewed: the direct approach by means of partial differential equations and the method of moving frames. Both techniques are appropriately illustrated with examples that point out the computational advantages and drawbacks.

In the second part of the book, Chapters 4-7, the authors discuss the main criteria and invariants that enable us to determine whether a given Lie algebra belongs to the class of nilpotent, solvable or Levi decomposable algebras, and more importantly, to decide whether two given Lie algebras are isomorphic or not. While for semisimple Lie algebras the distinction follows easily from the classical theory, for non-semisimple algebras the separation of isomorphism classes rapidly becomes a cumbersome problem, especially in the case of parameterised families of solvable real Lie algebras. The four chapters are dedicated respectively to the elementary invariants of structure tensors, the decomposition of Lie algebras into direct sums of ideals, the Levi decomposition theorem and the nilradical (i.e., maximal nilpotent ideal) of a Lie algebra. Carefully chosen examples to illustrate the various steps are developed. For the sake of completeness, the authors include three algorithms that can be conveniently implemented in a computer system and that facilitate considerably the computations. More detailed information on how to implement these algorithms is given later, at the beginning of part four.

Part three (Chapters 8-14), which can be considered the core of the book, focuses on the analysis of various different classes of solvable Lie algebras possessing a nilradical of certain type. This part contains material that has appeared almost entirely in different journals in the last two decades, and hence appears for the first time in book form. Far from being a sterile academic exercise, the types of Lie algebras studied in these chapters have arisen in different applications, mainly in the context of Differential Geometry or physical phenomena. First of all, in Chapter 8 various important properties of nilpotent algebras are revisited, like the notion of external tori of derivations, their rank and the extensions by derivations of Lie algebras, where the cohomological approach is used. Actually, this technique of extending nilpotent Lie algebras by semisimple derivations constitutes the main tool employed in obtaining the large classes in arbitrary dimensions developed in later chapters. Among the types of nilradicals considered, three major groups can be distinguished: nilpotent algebras having a low nilpotence index, like Abelian and Heisenberg algebras (the latter being the most obvious representative of metabelian Lie algebras). At the opposite side, nilpotent Lie algebras with maximal and almost maximal nilpotence index (called filiform and quasi-filiform, respectively). These algebras usually exhibit quite low ranks that enable the explicit computation of their derivations. As a special and important case with varying nilpotence index, the third class consists of nilradicals of Borel subalgebras, deeply related to root systems and containing relevant structures such as the algebra of strictly upper triangular matrices.

Solvable real Lie algebras having a nilradical of the preceding type are classified in arbitrary dimension, along with their generalised Casimir invariants. The final chapter of this part deals with Lie algebras admitting a nontrivial Levi decomposition. Depending on the nature of the characteristic representation of the Levi factor, various criteria concerning the nature of the radical are obtained. From the point of view of representation theory, Levi decomposable algebras are of special interest, as they are naturally related to the branching rules of semisimple Lie algebras and the problem of regular/singular embeddings of semisimple subalgebras. To illustrate the implementation of the Levi-Mal'cev decomposition, the authors also include the classification of such algebras up to dimension 7.

The fourth part, comprising Chapters 15-19, deals with the explicit classification of real Lie algebras of dimensions at most six. The main value of this part consists in the fact that it constitutes the most recent revision and amendment of existing classifications, having been completely reformulated and presented in unified form. Many ambiguities and inaccuracies in the literature have been carefully corrected here, providing an easy-to-read list containing the main properties of each isomorphism class. In Chapter 15 a description of the symbolic computer packages used as an auxiliary tool to check and separate isomorphism classes is given, the remaining chapters being devoted to the classification in dimensions 3, 4, 5 and 6 respectively. The main data given for any Lie algebra in these lists are: the structure tensor, the upper central, central descending and derived series, restrictions on the parameters (if any) and the generalised Casimir invariants of the coadjoint representation. It should be observed that the authors have introduced a notation of their own, in order to avoid conflict with existing notations. The high visibility of the list facilitates the comparison with the other published classifications, simplifying the usually tedious localisation of omissions or mistakes.

The extensive list of references contains many of the classical monographs on the subject of Lie algebras and representation theory, as well as an updated list of original papers studying different Lie theoretic problems of current interest in applications, providing a good insight into the kind of situations where Lie algebra techniques constitute a powerful and efficient tool.

Summarising, this book is a highly welcomed addition to the bookshelf and will certainly become a valuable and indispensable tool for the practitioner in Lie theory, as it presents in condensed form a huge quantity of information dispersed in the technical literature. This work shall not be understood as a textbook in the classical sense, as it requires a certain acquaintance with Lie algebras and representation theory and the reader is often led to the original literature, but as a compendium and dictionary of modern techniques for the practical identification and classification of Lie algebras appearing in either physical or mathematical problems like the symmetry analysis of differential equations, control theory, General Relativity or (quantum) integrable systems.

More Fallacies, Flaws & Flimflam

by Edward J. Barbeau

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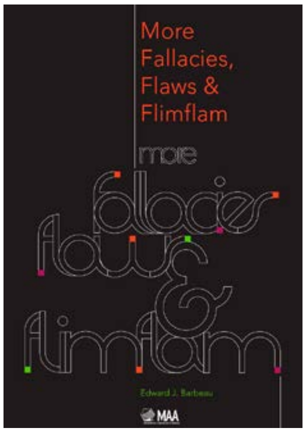

Ed Barbeau's College Mathematics Journal column *Fallacies, Flaws & Flimflam* has been entertaining mathematicians for years. *More Fallacies, Flaws & Flimflam* is the second collection of articles chosen primarily from this column. Readers who enjoyed *Mathematical Fallacies, Flaws, and Flimflam* will enjoy this book as well but having read the first book is definitely not a prerequisite for the new book.

The book is a compendium of examples of bizarrely done mathematics and is organized in sections on traditional subjects. Chapter 1 is titled Arithmetic and has many examples of numbers being used in strange ways. Elementary school teachers may find some examples in this chapter that are useful to them but the book comes alive with examples for middle school and secondary school, in particular Chapters 1, 2, 3, 7 and 8 which are Arithmetic; School Algebra; Geometry; Combinatorics; and Probability and Statistics. The remaining chapters are Limits, Sequences, and Series; Differential Calculus; Integral Calculus; Complex Analysis; Linear and Modern Algebra; and Miscellaneous.

The presentations of the examples vary with some having detailed explanations of what has gone wrong (or inadvertently right) and others leave the reader with an emotional need to find out what really happened in that problem.

Part of the fun of reading this book is thinking about what is really going on in each example. As mathematicians tend to like to classify things, this review classifies some of these examples not by their mathematical content but by their flimflam.

Mathematically incorrect reasoning — Mathematically correct results

Sometimes the mathematical thought process presented is wrong but the answer comes out correctly. One such exercise, Article 1.4, *Addition by juxtaposition*, was given by Brendan Kelly to his cadet teachers. When adding two fractions with single digit numerators and a common single digit denominator, juxtapose the denominator with itself, juxtapose the numerators both ways (as addition does not depend on the order of adding the fractions) and then add.

$$2/9 + 5/9 = 25/99 + 52/99 = 77/99 = 7/9.$$

This always works. The book does not provide the proof but one is easy to discover for the algebraically inclined. This would be an interesting task to assign to students in a teacher training program and to students in late high school or early college.

Moving from numbers into calculus, Article 5.2, *A simple way to differentiate a quotient*, gives an example by Anand Kumar where a student has obtained the correct derivative of a quotient by using the rule (believed by many students) that $\left(\frac{f}{g}\right)' = \frac{f'}{g'}$. Details are provided for $f(x) = -(1-(3/x))^{-3}$ and $g(x) = -x^3$. Several other examples are given where this rule also works. An interesting question to pose to students would be to find other examples for which this rule holds.

Nonsensical news

There are several articles that demonstrate the lack of understanding of mathematics by those that publish news. A *Toronto Star* report (Article 1.7 — *Hot stuff in Canada*) included

52% warmer this month
April 1 – 8 average temp. 7.9 C
Normal average 5.2 C

One is left wondering what people think percentage means.

Article 3.2, *Important knowledge about triangles*, illustrates that then Governor Jeb Bush did not know what the angles in a three-four-five triangle are. In fact, the quote in the book shows that not only did some secondary school students not know the answer but also that some Associated Press editors could not tell that the students did not know.

The meaning of mathematical words

Mathematicians like to give technical meaning to standard words. Sometimes students (deliberately?) use the non-technical meaning of the word and create hilarious situations. Article 2.1, *Very funny Peter*, is one such situation. Is this another urban myth or, as suggested, a genuine student submission?

Expand $(a\ +\ b)^n$.

$(a\ +\ b)^n = (a\ \ +\ \ b)^n = (a\quad+\quad b)^n = (a\qquad+\qquad b)^n = \cdots$

Morality tales for teachers: the work matters

In items that might appear under the heading of *Mathematically incorrect reasoning — Mathematically correct results*, it is often clear in the presentation that there is a mathematical misunderstanding happening. At other times the mathematical thought process appears to be on much firmer ground and the final number is correct but careful analysis shows incorrect implementation of rules of mathematics. This is illustrated in Article 6.7, *Several wrongs make a right*, where repeated mistakes in an integration problem lead to the correct numerical answer. This example is a firm reminder to markers everywhere that looking at the first line and the last line is not a sufficient action for giving 100% on a test question. (Especially since students hope that happens!)

In Article 5.13, *Falling ball*, a standard calculus problem is presented along with a solution by a student of Karl Havlak.

> A ball is dropped from the top of a building and hits the ground with a speed of 128 feet per second. Approximate the height of the building.

The usual formula of $s(t) = -(g/2)t^2 + v_0 t + s_0$ is given along with the calculations of the student. These calculations involve the formula $s(t) = -16t^2 + 128t$ and the statement that the velocity is 0 for an instant when the ball hits the ground. The task suggested by Havlak is explaining to the student what is wrong. Another option is to put the incorrect solution on a test and ask the students to explain what is wrong, thereby challenging their analytical skills.

Morality tales for teachers: the question matters

Article 2.3, *An algebra problem*, provides a question from a test.

Solve for x: $$\frac{5(2x-6)}{7} = \frac{3(4x-12)}{2}.$$

Apparently students either ignored the 7, ignored the 2, or ignored both and still got the correct answer. As pointed out in the book, $x-3$ is a factor on both sides. One does wonder what the point of giving this question to the students was.

In Article 3.3, *The perimeter of a triangle*, Peiyi Zhao provides the following from problems for social science students in China:

> In a given triangle $\triangle ABC$, the ratio of the angles is given by $A:B:C = 2:3:4$ and that of two of the sides by $AB:BC = 3:2$. Also, $AC = 5$. Find the perimeter of $\triangle ABC$.

A logically correct answer is provided and then shown to be wrong. This can be done because there is too much information in the question leading the question to be internally inconsistent.

Article 8.1, *Chance of meeting*, gives the following problem:

> A and B are standing at the respective points $(0,0)$ and $(2,1)$ in a square grid. At the same instant, with the same speed, each walks towards the position of the other. A moves only to the right and up, while B moves only to the left and down; both must travel on grid lines. What is the probability that they will meet?

Two solutions are given. They are both correct but one gives the probability as $1/3$ and the other as $5/16$. In this situation different, but equally valid, assumptions are made showing that insufficient information is provided. An untrained marker would likely mark one of these as incorrect.

Morality tales for teachers: the answers are the same

Amusingly, Article 6.1, *Integration discrepancies?*, is a meta-example that could fall under the next category as there is a typographical error in the statement of the problem that appears to belong to the author of *More Fallacies, Flaws & Flimflam*.

The intended example is to integrate $\int \frac{x}{(x-1)^2}dx$. An integration by parts solution and a substitution solution yield

$$\frac{-x}{x-1} + \ln(x-1) + C \qquad \texttt{and} \qquad \ln(x-1) - \frac{1}{x-1} + C.$$

The careful marker will realize these differ by a constant so are equally valid. This is another example where an untrained marker would likely mark one of these as incorrect.

Morality tales for textbook authors: mean what you say

Authors (and teachers) don't always say what they mean. The following theorem is provided from a well known calculus textbook's sixth edition.

> The derivative of the sum (or difference) of two differentiable functions is differentiable and is the sum (or difference) of their derivatives.

It may take more than one reading to realize what is wrong with this statement. Read Article 5.4, *A strong differentiability condition*, to find out which book it is from.

Article 10.10, *If it's in the Textbook, it must be true*, provides a wonderful anecdote from Donald A. Teats about a numerical analysis examination and the concept of diagonally dominant. A matrix is *diagonally dominant* if the absolute value of the diagonal entry in each row is greater than the sum of the absolute values of the off-diagonal entries in that row. The key part of this definition is the phrase *greater than*. It is not *greater than or equal to*. Teats explains in detail how a bright student asking questions led him to realize that several editions of two different, widely used textbooks had an error involving the difference between *greater than* and *greater than or equal to*.

The remaining flimflam in the book will provide the reader with much laughter and more awareness of how mathematics goes wrong for students.

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

Les articles sur l'éducation présente 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 des nouvelles d'intérêt. Vos commentaires, suggestions et propositions sont le bienvenue.

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Should (or does) mathematics education research inform our mathematics teaching practices?

Est-ce que la recherche en didactique des mathématiques informe (ou devrait informer) notre enseignement des maths?

Chantal Buteau *(Brock University)*,
Nadia Hardy *(Concordia University)*,
Joyce Mgombelo *(Brock University)*

Does (should) mathematics education research inform our mathematics teaching practices?[1] This remains a widespread debate among the mathematics education community; it stems from a perceived gap between research in mathematics education and its potential to change teaching practices. It is in this context that the theme of the one-day Canadian Mathematics Education Study Group (CMESG) Pre-conference on *Mathematics Education Research and Mathematics Teaching: Illusions, Reality, and Opportunities,* hosted at Brock University in May 2013, was framed. At the event, some 90 math educators, 47 CMESG delegates and 43 local community members, came together to reflect on the gap between mathematics education research and the practices in the mathematics classrooms.

La réflexion a eu lieu par le biais d'un exposé plénier par John Mason[2] et des groupes de travail pour chaque niveau d'enseignement. Elle a été guidée par les questions suivantes: *Quelle recherche informe l'enseignement des mathématiques? Comment cette recherche vient-elle à être mise en pratique? Quels sont les problèmes et les lacunes?* Dans cet article, nous résumons les principales idées discutées à propos du niveau universitaire et l'exposé plénier. Nous concluons avec quelques questions et préoccupations au sujet des questions soulevées par le conférencier plénier et les participants.

A summary of John Mason's keynote: Responsive and Responsible Teaching[2]

Responsive teaching: involves thoughtful response to learner behaviour, informed by principles and assumptions about learning. The teacher, however, may not have a discourse to justify actions or choices.

Responsible teaching: the choices to act and the expected results, both when preparing and in the minute-by-minute flow of the classroom, can be clearly articulated and justified through the use of technical terms, assumptions and values.

Mathematics education, as a research domain, has the responsibility to promote *responsible teaching*, stimulating teachers to bring assumptions, actions and other practices to articulation so that they can be compared and used to justify or challenge established practices. This claim is founded on the growing evidence that teaching practices are effective *only* when teachers understand the principles underpinning them. This understanding and the articulation and justification of choices require a certain degree of acquaintance with mathematics learning theories and their values and assumptions as they concern the lived experiences of mathematics learners.

En ce sens, de la recherche en didactique qui peut apporter quelque chose d'utile au développement curriculaires et aux pratiques en classe devrait mettre en évidence des actions et sensibilités à l'égard de ces actions, tout en montrant clairement comment elles s'alignent avec les hypothèses et les valeurs sur l'apprentissage des mathématiques (i.e., avec les théories de l'apprentissage), et la façon dont elles se déroulent dans des situations particulières, sans essayer de prétendre que ceci ou cela 'fonctionne'; voici pourquoi.

There are two major gaps in the research-practice domain of mathematics education: between researchers and policy makers, and between researchers and teachers. The pragmatics of education means that policy makers, leaders and teachers would like to know what 'works' and what does not. But all attempts to turn theories into recipes for action will flounder because human beings are agentive organisms not machines, and trained behaviour may only 'work' in local conditions. Certainly, training mechanical aspects of human behaviour can be successful, but only temporary; as soon as conditions change, trained behaviour becomes useless without educated awareness to guide it, which is why 'drill and practice' can get learners through tests and even a few examinations, but leaves them feeling they don't understand, and vulnerable to changed conditions. This applies both to teachers and to learners. Cause-and-effect is not a dominant mechanism when human beings are involved. There are no practices that 'work' independently of the context and conditions, and the variables involved cannot be specified sufficiently precisely, or perhaps even enumerated, so as to

1 Tell your opinion at: http://mathedresearchandpracticegap.pbworks.com

2 This summary is based on our interpretation of Prof. Mason's presentation and on the short abstract he wrote for the promotion of the event.

guarantee results. If research in mathematics education is taken as a tool for deciding between different teaching actions, then great care is needed to discern the relevant conditions and context that make those actions 'work'.

From this perspective, 'valuable results' in mathematics education research are, for example, those that reveal different

- ways in which learners re-construct procedures from fragments of other procedures;
- ways that learner attention can be induced to shift towards what is mathematically significant;
- ways of inducing learners to encounter challenges they would not otherwise have considered.

But how such research comes to be put into practice? Effective mediation between research and practice involves the design of curricula and tasks clearly aligned with assumptions and values about learning, so teachers (and also students) may articulate and justify their practices. This may lead to challenging assumptions, predispositions and perspectives about teaching and learning, but the goal is that this questioning takes place within a supportive and sustained environment so that changes in the discourse go hand in hand with changes in practices and changes in perspective. What matters is what the learner experiences and the being of the teacher in relation to both learners and mathematics. Mathematics education has a long history of looking for simple cause-and-effect, for 'silver bullets' that will have immediate and significant impact on learner performance. But teaching is a caring profession and teaching mathematics is about caring passionately for learners and for mathematics, and for relationships between people and mathematics.

The underlying metaphor of education as a factory based on the mechanism of simple cause-and-effect needs to be challenged at every level. Maintaining complexity, respecting human beings as agentive, desirous and value-directed, and respecting mathematics as a mode of enquiry and world-perspective requires on-going elaboration and support.

For more details see Mason's various writing and publications at his website: http://mcs.open.ac.uk/jhm3/.

Mathematics teaching at university level[1]: How big of a gap is there between mathematics education research and teaching practices?

The focus of the working group (WG) was on the teaching of introductory mathematics courses (mostly Calculus and Linear Algebra) as it was claimed that the issues around teaching these courses are significantly different to those around the teaching of advanced mathematics courses (such as Abstract Algebra or Measure Theory) and time was insufficient to address all. The WG participants (a group of 12 professors, researchers and graduate students) stressed several aspects of a perceived gap between research and the realities of the everyday teaching of these courses. In particular, they pointed out that related research often constrains its own capability of being put into practice since it considers ideal situations that are far from the realities of classrooms and students, and of teachers and their constrained practices. For example, research seldom takes into account students' diverse backgrounds, class-size and -time, and other institutional constraints such as how powerless are the instructors of introductory courses to alter or influence curriculum design and everything that it involves (they don't choose content, often not even the order in which content is presented, they have little or no control at all over assessment, textbook choice, etc.).

À la question de quelle recherche pourrait être 'utile' pour l'enseignement, un groupe de participants a plaidé pour la recherche normative, i.e., qui prescrit une approche pédagogique qui 'fonctionne': "si on enseigne de telle ou telle façon, les élèves apprendront/comprendront". Une discussion s'en est suivie, à partir des critiques formulée, lors de la présentation plénière, à l'endroit du paradigme de recherche 'cause et effet'. Les didacticiens en mathématiques qui participaient au groupe de travail (qui étaient pour la plupart également professeurs d'université de mathématiques) ont reconnu la frustration des professeurs d'université qui sentent leur liberté académique – qui devrait inclure la liberté d'explorer et de remettre en question les hypothèses institutionnelles et personnelles, les prédispositions et les perspectives sur l'enseignement et l'apprentissage – plus souvent qu'autrement bafouée par les pratiques institutionnelles actuelles.

Further comment by the authors

The view that research in mathematics education should be of prescriptive nature, providing 'scientific' evidence that such and such teaching approach 'works' or 'doesn't work' seems to have gained popularity among the many educational stakeholders. The keynote speaker argued against a cause-and-effect approach to research in (mathematics) education, emphasizing its humanistic and social nature. Other researchers have expressed further worries with this approach (e.g., Biesta, 2010; Lerman, 2010): the question of what 'works' and what doesn't assumes that the ends of education are given, and that the only relevant questions to be asked are about the most effective and efficient ways of achieving those ends. Focusing on 'what works' makes it difficult, if not impossible, to ask questions of what it should work *for* and who should have a say in determining the latter.

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The pre-conference was supported by the Fields Institute, Brock University, and Pearson Publishing Company.

1 The working group was led by Nadia Hardy (Concordia University). The summary presented here is based on notes taken during interactions in the working group.

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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Les articles de recherche présente 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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How To Analyse Hamiltonian Non-integrability

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Serious progress in science goes by shocks and jumps, and this also holds for the personal development of a scientist. For me, one of such big shocks was the realisation of the phenomenon of non-integrability of Hamiltonian systems. We all know the pictures of the phase-plane of the mathematical pendulum and other well-organized two-dimensional phase-planes. Considering more dimensions, one expects richer and more complicated pictures, probably more difficult to describe but not essentially different. In 1964 appeared a paper by Hénon and Heiles [1] that changed our perspective of Hamiltonian systems completely. This paper describes a simple looking four-dimensional (two-degrees-of-freedom) Hamiltonian system. To visualise the flow, the authors used a Poincaré-map, which means that they restrict the flow to an energy manifold near stable equilibrium and consider then a two-dimensional transversal of the flow. This transversal plane is mapped into itself by the flow whereas the equilibrium corresponds with a fixed point as do simple periodic solutions. A naive prediction of such a Poincaré-map would be a series of smooth curves around the fixed points corresponding with the intersections of the three-dimensional manifolds embedded on the energy manifold. For small energies ($\approx 1/12$), very near to stable equilibrium, the authors of [1] found such a picture, but for a little bit larger values of the energy, the smooth curves were broken up, resulting in a wild spattering of points generated by the Poincaré-map. Later, this phenomenon was identified with homoclinic chaos as predicted by Poincaré in the nineteenth century; for a description see [3]. In fig. 1 we present the time series $H_2(t)$ for the Hénon-Heiles system at an energy level where chaotic motion can easily be identified.

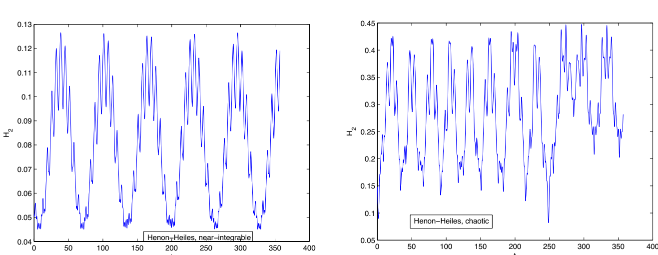

Figure 1 Left: the time series $H_2(t)$ in the near-integrable regime of the Hénon-Heiles problem, $H_2(0) = 0.05125, H(p,q) = 0.05308$; the fluctuations are small and reflect quasi-periodic motion. Right: the time series $H_2(t)$ in the chaotic regime of the Hénon-Heiles problem, $H_2(0) = 0.14815, H(p,q) = 0.13959$.

For an autonomous Hamiltonian system with n degrees-of-freedom, n independent integrals suffice for integrability, there will be no chaotic motion in such a system. Much of the confusion among scientists regarding integrability and non-integrability arose from the integration of the Newtonian two-body problem. This problem is even super-integrable, i.e. it has six degrees-of-freedom but even more than six independent integrals; this is caused by its spherically symmetric potential. It added to the confusion that in problems of physics, simplification often leads to symmetry assumptions, producing new integrals besides the Hamiltonian. These examples and models are not typical for the general Hamiltonian case.

In the seventies of last century, we started in Utrecht with the computation and analysis of normal forms of Hamiltonian systems near equilibrium. Introductions and surveys of results can be found in [2] and [4]. One starts with an n degrees-of-freedom system with Hamiltonian $H(p,q)$ that can be expanded near equilibrium to a certain order as:

$$H(p,q) = H_2(p,q) + H_3(p,q) + \ldots + H_m(p,q) + \ldots$$

The polynomials $H_i, i = 2, 3, \ldots$ are homogeneous in the variables p, q.

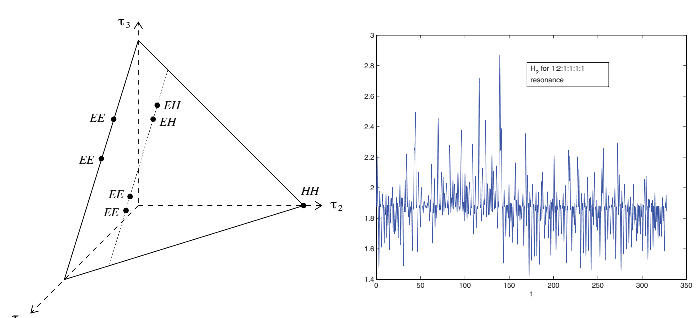

Figure 2. Left: the energy simplex for the non-integrable normal form of the $1:2:1$ resonance; there are seven families of periodic solutions of which four are stable (EE). Right: $H_2(t)$ of the $1:2:1:1:1:1$ resonance which is non-integrable with non-integrable normal form.

Sometimes, other coordinate systems are useful, for instance action-angle variables $\tau_i, \phi_i, i = 1 \ldots n$. The technique of normalisation was developed by Poincaré, Birkhoff and modern scientists using analytic and algebraic tools. A basic element is that the resonances that exist near equilibrium produce resonant terms that are kept in the normal form while the non-resonant terms are averaged away. Such a normal form $\bar{H}(p,q)$ does generally not converge when $m \to \infty$, but a finite expansion contains already a lot of quantitative and qualitative information. Quantitative, as we have explicit error estimates for the solutions and integrals of the normal form as related to the original Hamiltonian. Qualitative, as the error bounds limit the dynamics of the original system to a kind of shadowing of the normal form dynamics. Moreover, some of the periodic solutions of the normal form, can be identified in the original system, see fig. 2. As the normalisation is canonical, $\bar{H}(p,q)$ is the Hamiltonian integral of the normal form, whereas, because of the normal form commutation relations, also $H_2(p,q)$ is an integral of the normal form system. This means that two-degrees-of-freedom normal forms are always integrable, they contain no chaos.

As an example we present some results in fig. 2 left for the $1:2:1$ resonance displaying only the three action variables τ_i of the six canonical variables. A dot corresponds with a periodic solution; the diagram is obtained from the normal form $\bar{H}(p,q) = H_2 + \bar{H}_3(p,q)$; H_3 has 56 free parameters, $\bar{H}_3$ six. The normal form is non-integrable as is the $1:2:1:1:1:1$ resonance normal form; on the right we display $H_2(t)$ which shows irregular behaviour as predicted.

Because of their high dimension, $2n-2$ for n degrees-of-freedom, Poincaré maps for systems with three or more degrees-of-freedom are not easy to study. Another possibility is to use time series of the dynamics. There exists an extensive reconstruction theory for time series associated with dissipative maps. However, the time series $H_2(t)$ is derived from a symplectic map where the analysis is largely unexplored. One promising possibility is to look for irregularities in the time series $H_2(t)$. If the orbit producing the time series traces quasi-periodic motion, $H_2(t)$ will look smooth. Jumpy and even non-smooth behaviour might predict non-integrability.

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[3] Ferdinand Verhulst, *Henri Poincaré, impatient genius*, Springer (2012)

[4] Ferdinand Verhulst, *Integrability and non-integrability of Hamiltonian normal forms*, to be publ. (2015)

CMS Member Profile

Harley Weston

HOME University of Regina, Regina, Sask.

RESEARCH Point Set Topology, Mathematical Modeling, Mathematics Education

LATEST PUBLICATION "Aboriginal perspectives and/in mathematics: a case study of three grade 6 teachers" (with Kathy Nolan, accepted)

CMS MEMBER SINCE 1969

SELECT ACHIEVEMENTS OR AWARDS 1992 University of Regina Alumni Association Award for Excellence in Undergraduate Teaching, 2007 PIMS Education Prize, 2008 CMS Adrien Pouliot Award.

HOBBIES Woodworking, Knitting

LATEST BOOKS READ A brief tour of human consciousness: from imposter poodles to purple numbers / V.S. Ramachandran. 2004

RECENT NEWS/PROJECTS Kathy Nolan and I have recently returned from our fourth trip to Yellowknife over the past 18 months where we worked with teachers to help them with including an Aboriginal perspective in their mathematics lessons.

WHAT I WOULD CHANGE I would like to see more mathematics educators and mathematicians in industry become members of the CMS.

CMS ROLES Math Camps Coordinator, Chair Education Camel Sub-Committee, Chair Education Committee, Mathematics Competitions Committee member, Distinguished Awards Selection Committee member.

WHY I BELONG TO THE CMS The CMS gives a voice to our community and helps us share our passion for the beauty of mathematics.

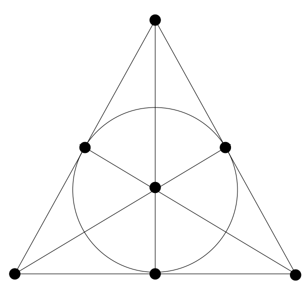
On the Dimension of Finite Linear Spaces

Peter J. Dukes, *Department of Mathematics and Statistics, University of Victoria*

There are few concepts in mathematics more pervasive than that of dimension. There are variations on the standard definition ('Hausdorff dimension' for metric spaces) and even language ('rank' for groups). But a naïve internet search [9] of dimension in mathematics turns up the expected headline: *The dimension of a space or object is the minimum number of coordinates needed to specify its points*. High school and early college mathematics leans heavily on this narrative. Here, let's explore what is essentially a dual (though closely related) notion: *The dimension of some space is the maximum number of points which always define a proper subspace.* This is seldom used, and (admittedly) not always appropriate. Yet it makes intuitive sense. In Euclidean 3-space, any three distinct points are either coplanar or collinear.

An advantage of the latter definition is that, while 'coordinates' warrants further discussion, it is normally quite clear what's meant by 'subspace'. In other words, (in many cases) it is overkill to use coordinates when defining dimension. All one really needs is the lattice of substructures. In this way, it is possible to consider dimension in the (very primitive) context of incidence geometry… even *finite* geometry!

Let us define a *linear space* as a pair $(X, \mathcal{L})$, where X is a set of *points* and $\mathcal{L} \subset 2^X$ is a family of subsets, or *lines* with the property that every pair of distinct points from X belongs to exactly one line. We are especially interested in the case where X (and hence $\mathcal{L}$) is finite. The figure below shows a linear space with 7 points known as the *Fano plane*. See [1] for a comprehensive reference on linear spaces and finite geometries.



These structures are central in design theory, except that there are usually restrictions on the allowed line sizes. Let n be a positive integer and $K \subset \mathbb{Z}_{\geq 2} := \{2, 3, 4, \dots\}$. A *pairwise balanced design* PBD(n, K) is a pair $(X, \mathcal{B})$, where X is an n-set of *points* and $\mathcal{B}$ is a family of *blocks* such that

- for each $B \in \mathcal{B}$, we have $B \subseteq X$ with $|B| \in K$; and
- any two distinct points in X appear together in exactly one block.

Note that there are numerical constraints on n given K. For instance, deleting any point $x \in X$ from its incident blocks must induce a partition of the remaining points. This leads to the *local condition*

$$\alpha(K) := \gcd\{k - 1 : k \in K\} \mid n - 1. \quad \text{(local)}$$

Also, the number of pairs of distinct points must be a (nonnegative) integral linear combination of the number of distinct pairs arising from blocks with sizes in K. This leads to the *global condition*

$$\beta(K) := \gcd\{k(k-1) : k \in K\} \mid n(n-1), \quad \text{(global)}$$

Wilson's theory, [8], asserts that (local) and (global) are sufficient for $n \gg 0$.

A *flat* (or *subspace*) in a linear space $(X, \mathcal{B})$ is a pair $(Y, \mathcal{B}|_Y)$, where $Y \subseteq X$ and $\mathcal{B}|_Y := \{B \in \mathcal{B} : B \subseteq Y\}$ have the property that any two distinct points in Y are together in a unique block of $\mathcal{B}|_Y$. Flats in $(X, \mathcal{B})$ form a lattice under intersection. That is, any set of points $S \subseteq X$ generates a flat $\langle S \rangle$ equal to the intersection of all flats containing S. Alternatively, $\langle S \rangle$ can be computed algorithmically starting from S by repeatedly including points on blocks/lines defined by previously included pairs.

The *dimension* of a linear space is the maximum integer d such that any set of d points is contained in a proper flat. For instance, the flat generated by any two points is the line containing them. So every 'nontrivial' linear space has dimension at least two.

Finite vector spaces provide examples with uniform line sizes. Let $\mathbb{F}_q$ the finite field of order q, a prime power. We can take as points $X = \mathbb{F}_q^d$, and as flats all possible translates of subspaces. This forms the *affine space* AG$_d(q)$. For example, AG$_4(3)$ recovers the popular card game 'Set', [10]. If you have a deck of these cards, check that any four cards are contained in a 'sub-deck' of size at most 27. With the one-dimensional flats as blocks, AG$_d(q)$ becomes a PBD$(q^d, \{q\})$ of dimension d.

In a slightly different direction, a *Steiner triple system* is a PBD$(n, \{3\})$. Here, (local) and (global) reduce to $n \equiv 1$ or $3 \pmod 6$, and in fact this is sufficient for existence of Steiner triple systems on n points. Now, a *Steiner space* is defined to be a Steiner triple system of dimension at least 3. Teirlinck in [7] considered the existence of Steiner spaces, finding that they exist if and only if $n = 15, 27, 31, 39$, or $n \geq 45$, except for possibly four (still) unsettled cases: $51, 67, 69, 145$.

The author and Alan C.H. Ling recently obtained an existence theory for large n given any K, d.

Theorem 1. (4) *Given* $K \subseteq \mathbb{Z}_{\geq 2}$ *and* $d \in \mathbb{Z}_+$, *there exists a PBD* (n, K) *of dimension at least* d *for all sufficiently large* n *satisfying* (local) *and* (global).

The Master's thesis of Joanna Niezen undertook a detailed investigation of the case $K = \{3, 4, 5\}$ and dimension three. Note that $\alpha(K) = 1$ and $\beta(K) = 2$, so (local) and (global) disappear, leaving all positive integers n as admissible.

Theorem 2. (6) *There exists a PBD*$(n, \{3, 4, 5\})$ *of dimension three if and only if* $n = 15$ *or* $n \geq 27$ *except for* $n = 32$ *and possibly for* $n \in E := \{33, 34, 35, 38, 41, 42, 43, 47\}$.

Actually, it is even possible to bound the sizes of the three-point-generated subspaces.

Theorem 3. *For large integers n, there exists a PBD($n, \{3,4,5\}$) such that any three points are contained in a flat of size at most 1000.*

An undergraduate student, Nicholas Benson, has recently improved 1000 to 94 in Theorem 3, and also obtained a constant (though very large) bound for general K, d in the spirit of Theorem 1.

Proofs of the above results essentially proceed by tinkering with the affine space $AG_d(q)$ (or its projective cousin). For example, points can be either deleted or expanded into small sets of points provided various ingredient designs are available.

In closing, it is worth mentioning one 'application' of Theorem 3 to a problem in extremal combinatorics. Consider proper n-edge-colourings of the complete bipartite graph $K_{n,n}$. (These are equivalent to 'latin squares' – a close relative of Sudoku squares.) The union of any two colour classes is a disjoint union of (even-length) cycles in the graph. One can then ask [2, 5] for the minimum, taken over all such colourings, of the longest two-coloured cycle. It is a straightforward consequence [3] of Theorem 3 that this minimum is a constant, even for $n \gg 0$. By a similar construction, there exist latin squares of order $n \gg 0$ in which any chosen cell and symbol appear together in a small subsquare. At first glance, these appear to be somewhat surprising results.

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JUNE CONTINUED

14-17 SSC **2015 Annual Meeting**, Dalhousie University, HalifaxInstitute for Operations Research and the Management Sciences, Montreal, Que.

15-16 FIELDS/**CRM Séminaire de Mathématiques Supérieures** - Geometric and Computational Spectral Theory, Montreal, Que.

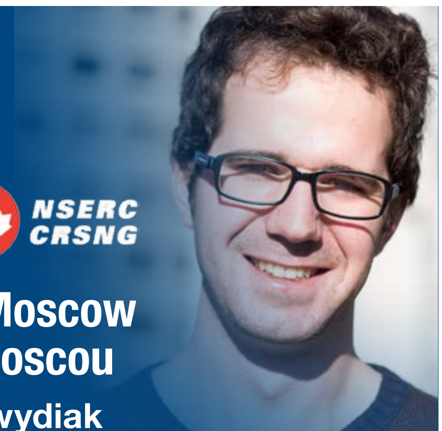
29 PIMS Symposium on the Geometry and Topology of Manifolds, University of British Columbia, B.C.

JULY 2015

6-8 AARMS **International Symposium in Statistics 2015**, Memorial University, St. John's, Nfld.

11-15 SIAM Annual Meeting, Boston, MA.

17-21 AARMS **AHA 2015**, Dalhousie University, Halifax, N.S.



CMS SMC — NSERC CRSNG

Math in Moscow
Math à Moscou

Stefan Dawydiak

The Math in Moscow scholarship acknowledges high-potential undergraduate students with an opportunity to participate in a unique fifteen-week-long research experience with some of the world's leading mathematicians at the renowned Independent University of Moscow. The 2014 scholarship recipient is Stefan Dawydiak (UBC) who will be attending the Moscow program in January 2015. The scholarship is a joint initiative of the CMS and the Natural Sciences and Engineering Research Council (NSERC).

La bourse Math à Moscou est remise à des étudiants de premier cycle au potentiel élevé et donne à ces étudiants l'occasion de participer à une expérience de recherche unique d'une durée de 15 semaines avec quelques-uns des plus illustres mathématiciens du monde entier, à l'Université indépendante de Moscou, établissement de renom. Le boursier de 2014 est Stefan Dawydiak (UBC). Stefan sera inscrit au programme à Moscou au mois de janvier 2015. La bourse est une initiative conjointe de la SMC et du Conseil de recherches en sciences naturelles et en génie (CRSNG).

CMS Notes
Volume 46 No. 6, December 2014

CSHPM Notes brings scholarly work on the history and philosophy of mathematics to the broader mathematics community. Authors are typically members of the Canadian Society for History and Philosophy of Mathematics (CSHPM). Comments, suggestions, and submissions are welcome.

Amy Ackerberg-Hastings, *University of Maryland University College (aackerbe@verizon.net)*

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

Les articles de la SCHPM présente des travaux de recherche en histoire et en philosophie des mathématiques à la communauté mathématique élargie. Les auteurs sont généralement membres de la Société canadienne d'histoire et de philosophie des mathématiques (SCHPM). Vos commentaries, suggestions et propositions sont le bienvenue.

Amy Ackerberg-Hastings, *University of Maryland University College (aackerbe@verizon.net)*

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

Who Hijacked the Philosophy of Mathematics?

Thomas Drucker, *University of Wisconsin–Whitewater*

A spectre is haunting the philosophy of mathematics—the spectre of Gottlob Frege. A quick survey of recent titles in the area suggests that Frege's work remains a focus of attention within the community of philosophers of mathematics. That is not so bad for someone with whom most mathematicians and historians are acquainted because of Bertrand Russell's success in puncturing Frege's dream of providing a formal foundation for arithmetic on the basis of logic. The story of Frege's rebirth is worth the telling, if only as a reminder of the ebb and flow of philosophical reputation.

The battle-lines within the philosophy of mathematics were laid out neatly at a conference in Königsberg in 1930. Representatives of the schools of formalism (associated with the name of David Hilbert), intuitionism (created by L.E.J. Brouwer), and logicism (Frege's perspective) engaged in a discussion on their respective views of the foundations of mathematics. The opening papers of the anthology on the philosophy of mathematics edited by Paul Benacerraf and Hilary Putnam, originally published in 1964 and republished in a second edition in 1983, are the printed versions of the discussions by John von Neumann, Arend Heyting, and Rudolf Carnap. The irony of the historical setting was the presence of Kurt Gödel at the conference, since he had already done work that could be interpreted as blowing up the possibility of Hilbert's formalism. As a result, of the three philosophical perspectives, one was sabotaged by Gödel's incompleteness results, one suffered from the changes it required in classical mathematics, and one was famously the victim of Russell's paradox.

Over the next few decades mathematicians began to develop a variety of foundational programs that went off in directions not dictated by the choices available at Königsberg. For example, the work in category theory that soon became the language for much of twentieth-century mathematics raised the issue of whether set theory deserved to have the foundational role standardly given to it in textbooks. The use of the computer in proving the Four Colour Theorem (as announced almost forty years ago) created lively discussion of the role the computer could and should play in extending the frontiers of mathematical knowledge. There was also the issue attendant upon Gödel's work of whether incompleteness could be used to demonstrate that computers were unable fully to do mathematics, a claim made by J.L. Lucas and part of the broader programme of foundations proposed by Sir Roger Penrose.

It was not as though Frege had disappeared from the philosophical map during the decades in the middle of the twentieth century. His work was taken as paradigmatic in the philosophy of language, and Michael Dummett, in particular, wrote at length about what Frege had to offer. Frege's article '*Über Sinn und Bedeutung*' (often translated as 'On Sense and Reference') was the starting-point for consideration of issues in the philosophy of language, and there was even a counter-literature arguing that Frege's work in the area was overrated (G.P. Baker and P.M.S. Hacker in their volume on Frege that was primarily an attack on Dummett). Frege's work on philosophy of mathematics was still seen as a failed enterprise, however.

Then a funny thing happened on the way to the 1980s. The principle of Frege that had been the target of Russell's criticism was called Basic Law V, which allowed for the construction of sets based on any property. George Boolos looked at the use that Frege made of Basic Law V and saw that there was a way of avoiding it by replacing it with what he called Hume's Principle. This asserts that the number of F's is equal to the number of G's if and only if there is a bijection between the F's and the G's. Since no Russell was able to find a paradox hidden under this particular approach to foundations, the neo-Fregean school has been flourishing.

Crispin Wright's 1983 book on Frege's conception of numbers as objects started the ball rolling, and the collection of papers on neo-Fregean issues in Bob Hale's and Wright's *The Reason's Proper Study* (Oxford, 2001) guaranteed that the twenty-first century could be launched in an atmosphere more favourable to the reception of Frege's ideas in mathematics than the twentieth had been. Of the four volumes devoted to Frege's work in the series on '*Critical Assessments of Leading Philosophers*' (published by Routledge in 2005), the third is devoted entirely to his philosophy of mathematics. The wave of Fregean scholarship continues with the work of Richard Heck, Jr. (whose *Reading Frege's* Grundgesetze was published by Oxford in 2012), Patricia Blanchette (*Frege's Conception of Logic*, also Oxford in 2012), and many others. Frege is even included in the volume *Logicomix* (by Doxiadis and Papapdimitriou) from 2009 as an example of the inseparability of madness and contemplation of the foundations of mathematics.

It is not so much that all the other currents of interest in the philosophy of mathematics from forty or fifty years ago have stopped flowing. Issues related to computers have taken on more importance as the machines themselves become more pervasive and objects of study across the disciplines. The connection between categories (in the form of topoi) and intuitionism is another way in which ideas brought up in Königsberg in 1930 remain alive. Frege's philosophy of mathematics, however, is a reminder that a shot in the technical arm can provide new life to a view that had already been showing signs of rigor mortis.

Thomas Drucker (druckert@uww.edu) teaches in UW–W's Department of Mathematics. He is also the Chair of the Philosophy of Mathematics Special Interest Group in the Mathematical Association of America.

CMS SMC

Réunion d'été 2015 de la SMC
Charlottetown - 5-8 juin

2015 CMS Summer Meeting
Charlottetown - June 5-8

June 5-8, 2015, Charlottetown (PEI)
University of Prince Edward Island
Host: University of Prince Edward Island

CALL FOR SESSIONS 2015 CMS Summer Meeting

The Canadian Mathematical Society (CMS) and the University of PEI welcomes and invites proposals for sessions for the 2015 Summer Meeting in Charlottetown from June 5th to 8th, 2015. Proposals should include a brief description of the focus and purpose of the session, the expected number of speakers, as well as the organizer's name, complete address, telephone number, e-mail address, etc. All sessions will be advertised in the CMS Notes, on the 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 by January 30, 2015.

Scientific Directors:

Gordon MacDonald: **gmacdonald@upei.ca**
Shannon Fitzpatrick: **sfitzpatrick@upei.ca**

Du 5 au 8 juin 2015, Charlottetown (Î.-P.-É.)
L'Université de l'Île du Prince-Édouard (UPEI)
Hôte : Université de l'Île-du-Prince-Édouard

APPEL DE PROPOSITIONS DE SÉANCES Réunion d'été 2015 de la SMC

La Société mathématique du Canada (SMC) et l'Université de l'Île du Prince-Édouard vous invitent à proposer des séances pour la réunion d'été 2015 qui aura lieu à l'Île-du-Prince-Édouard du 5 au 8 juin 2015. Ces propositions doivent compter une brève description de l'orientation et des objectifs de la séance, le nombre de conférenciers prévu, de même que le nom, l'adresse complète, le numéro de téléphone et l'adresse électronique de l'organisateur. Toutes les séances seront annoncées dans les Notes de la SMC, sur le site Web et dans les AMS Notices. Les conférenciers devront présenter un résumé, qui sera publié sur le site Web et dans le programme de la réunion. Toute personne qui souhaiterait organiser une séance est priée de faire parvenir une proposition aux directeurs scientifiques au plus tard le 30 janvier 2015.

Directeurs scientifiques :

Gordon MacDonald : **gmacdonald@upei.ca**
Shannon Fitzpatrick : **sfitzpatrick@upei.ca**

Adrien Pouliot Award / Prix Adrien-Pouliot

Frédéric Gourdeau (Laval)

The Adrien Pouliot Award recognizes individuals who have made significant and sustained contributions to mathematics education in Canada. The 2014 award recipient is Professor Frédéric Gourdeau (Laval) for his unparalleled commitment to mathematics instruction and his leadership in strengthening ties between practitioners and educators. The award is named for Adrien Pouliot, the second CMS President, who taught mathematics at Université Laval for 50 years.

Le prix Adrien-Pouliot rend hommage à des personnes qui ont apporté une grande contribution soutenue à l'enseignement des mathématiques au Canada. Le lauréat du prix en 2014 est le professeur Frédéric Gourdeau (Laval) pour son engagement inégalé à l'égard de l'enseignement des mathématiques et son leadership dans le but de resserrer les liens entre les praticiens et les enseignants. Le prix a été nommé en l'honneur d'Adrien Pouliot, le deuxième président de la SMC, qui a enseigné les mathématiques à l'Université Laval pendant 50 ans.

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

Kenneth R. Davidson (Waterloo)

The David Borwein Distinguished Career Award recognizes individuals who have made a sustained outstanding contribution to the advancement of mathematics. The 2014 award recipient is Kenneth R. Davidson (Waterloo) for his distinguished contributions to scientific leadership combined with his teaching and scholarship. The award is named for David Borwein, a distinguished mathematician and former CMS President; the award was established through a generous gift from the Borwein family.

Le Prix David Borwein de mathématicien émérite pour l'ensemble d'une carrière est décerné à une personne qui a fait une contribution exceptionnelle et soutenue aux mathématiques. Le lauréat du prix en 2014 est Kenneth R. Davidson (Waterloo) pour sa contribution exceptionnelle au leadership scientifique, sans compter son enseignement et sa recherche. Le prix a été nommé en l'honneur de David Borwein, éminent mathématicien et ancien président de la SMC. Le prix a été créé grâce à un don généreux de la famille Borwein.

Doctoral Prize / Prix de doctorat

Xiangwen Zhang (McGill)

The Doctoral Prize recognizes outstanding performance by a doctoral student who graduated from a Canadian university in the preceding year and whose overall performance in graduate school is judged to be the most outstanding. Other publications, activities in support of students and other accomplishments are also considered. The 2014 award recipient is Xiangwen Zhang (McGill) for his thesis "Complex Monge-Ampère Equation and its Applications in Complex Geometry."

Le Prix de doctorat souligne le rendement exceptionnel d'un étudiant au doctorat qui a obtenu un diplôme d'une université canadienne au cours de l'année précédente et dont le rendement général pendant ses études de deuxième cycle est considéré comme étant des plus exceptionnels. On tient compte d'autres publications, d'activités menées à l'appui des étudiants et d'autres réalisations. Le lauréat du prix en 2014 est Xiangwen Zhang (McGill) pour sa thèse intitulée « Complex Monge-Ampère Equation and its Applications in Complex Geometry ».

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

Jonathan M. Borwein (Newcastle, NSW)
Armin Straub (Illinois)
James Wan (Newcastle, NSW)
Wadim Zudilin (Newcastle, NSW)
Jan Nekovář (Université Pierre et Marie Curie)





The G. de B. Robinson Award recognizes outstanding contributions to the Canadian Journal of Mathematics (CJM) or the Canadian Mathematical Bulletin (CMB). The 2014 award recipients are Messrs. Borwein (Newcastle, NSW), Straub (Illinois), Wan (Newcastle, NSW), and Zudilin (Newcastle, NSW) for their CJM paper "Densities of Short Uniform Random Walks" and Jan Nekovář (Université Pierre et Marie Curie) for his CJM paper "Level Raising and Anticyclotomic Selmer Groups for Hilbert Modular Forms of Weight Two." The award is named in honour of Gilbert Robinson, the third CMS president and a founder and managing editor of CJM.

Le Prix G. de B. Robinson souligne une contribution exceptionnelle au Journal canadien de mathématiques (JCM) ou au Bulletin canadien de mathématiques (BCM). Les lauréats du prix en 2014 sont Messieurs Borwein (Newcastle, NSW), Straub (Illinois), Wan (Newcastle, NSW) et Zudilin (Newcastle, NSW) pour leur article paru dans le JCM et intitulé « Densities of Short Uniform Random

Walks » et M. Jan Nekovář (Université Pierre-et-Marie-Curie) pour son article dans le JCM intitulé « Level Raising and Anticyclotomic Selmer Groups for Hilbert Modular Forms of Weight Two ». Le prix a été nommé en l'honneur de Gilbert Robinson, le troisième président de la SMC et un des fondateurs et rédacteur gérant du JCM.

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

Shawn Godin (Cairine Wilson Secondary School)

The Graham Wright Award for Distinguished Service recognizes individuals who have made significant and sustained contributions to the Canadian mathematics community and the CMS. The 2014 award recipient is Shawn Godin (Cairine Wilson Secondary School) for his substantial contributions and engagement as a member of the CMS and his leadership in mathematics and science education. The award is named in honour of Dr. Graham Wright (Ottawa) who served as the CMS Executive Director and Secretary for over 30 years.

Le Prix Graham Wright pour service méritoire souligne une personne qui a fait une contribution significative et soutenue à la communauté des mathématiques du Canada et à la SMC. Le lauréat du prix en 2014 est Shawn Godin (École secondaire Cairine Wilson) pour sa contribution et son engagement importants comme membre de la SMC et son leadership en enseignement des mathématiques et des sciences. Ce prix a été nommé en l'honneur du Dr Graham Wright (Ottawa), qui a été directeur exécutif et secrétaire de la SMC pendant plus de 30 ans.

Jeffery Williams Prize / Prix Jeffery-Williams

Askold Khovanskii (Toronto)

The Jeffery Williams Prize recognizes mathematicians who have made outstanding contributions to mathematical research. The 2014 recipient is Askold Khovanskii (Toronto) for his research in the area of pure mathematics. The prize is named in honour of Ralph Jeffery, the fourth CMS president, and Lloyd Williams, CMS treasurer for 20 years, both of whom also contributed greatly to the formation and success of the Canadian Mathematical Congress.

Le Prix Jeffery-Williams est décerné aux mathématiciens qui ont fait une contribution exceptionnelle à la recherche en mathématiques. Le lauréat du prix en 2014 est Askold Khovanskii (Toronto) pour sa recherche dans le domaine des mathématiques pures. Le prix porte le nom de Ralph Jeffery, quatrième président de la SMC, et de Lloyd Williams, trésorier de la SMC pendant 20 ans. Tous deux ont également contribué de manière significative à la formation et à la réussite du Canadian Mathematical Congress.

2015 CMS ELECTION NOTICE

PRÉAVIS D'ÉLECTION DE 2015 DE LA SMC

At the 2015 Annual General Meeting (AGM), the CMS will be holding an election of some members for the CMS Board of Directors. Members typically serve for a four year term. An advance poll is expected to take place before the AGM and the actual vote will take place and be tallied at the AGM. Anyone with an interest in becoming a member of the CMS Board of Directors or wishing to nominate a colleague to be a member is invited to make their interest known, via email, to the CMS Corporate Secretary, Johan Rudnick, at director@cms.math.ca.

Lors de l'assemblée générale annuelle (AGA) de 2015, la SMC procédera à l'élection de certains membres du Conseil d'administration de la SMC. Les membres siègent généralement pour un mandat de quatre ans. Un vote par anticipation devrait avoir lieu avant la tenue de l'AGA. Le scrutin réel aura lieu lors de l'AGA et les voix seront comptées à la même occasion. Toute personne qui souhaite devenir membre du Conseil d'administration de la SMC ou désigner un collègue pour être membre est invitée à en informer le Secrétaire général de la SMC, Johan Rudnick, par courrier électronique (directeur@smc.math.ca).

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2015 CRM - Fields - PIMS Prize

Professor Kai Behrend of the University of British Columbia.

Professor Behrend is an internationally recognized leader in the field of algebraic geometry, whose contributions to the subject are noted both for their depth and scope. He has obtained fundamental results in the theory of algebraic stacks, Gromov-Witten theory and the study of Donaldson-Thomas invariants. In particular, his pioneering works on the construction of a "virtual fundamental class" played a key role in laying the algebraic foundations of the Gromov-Witten theory. Later, he made a breakthrough in the study of the Donaldson-Thomas invariants by showing that, for certain spaces, the degree of the virtual fundamental class could be expressed as the topological Euler characteristic weighted by a natural constructible function, depending only on the intrinsic properties of the space. This function is now widely known as Behrend's function. It allowed the use of motivic methods to compute Donaldson-Thomas invariants, and made it possible to obtain their categorified and motivic versions, which is currently among the hottest trends in the subject. In his earlier work, Professor Behrend obtained an important generalization of the Lefschetz trace formula for algebraic stacks, presently known as Behrend's trace formula. The ideas put forward by Kai Behrend have already proven to be immensely influential and will undoubtedly have a lasting impact on this area of mathematics.

Kai Behrend received a Ph.D. in 1991 at the University of California, Berkeley. He joined the faculty of the University of British Columbia in 1994. Professor Behrend has received numerous recognitions for his research, including the 2001 Coxeter-James Prize and the 2011 Jeffery-Williams Prize of the Canadian Mathematical Society, as well as an invitation to speak at the International Congress of Mathematicians in Seoul in 2014.

Prix CRM-Fields-PIMS 2015

Professeur Kai Behrend de la University of British Columbia.

Le Professeur Behrend est un leader internationalement reconnu dans le domaine de la géométrie algébrique dont les contributions à ce sujet sont appréciées pour leur profondeur et leur étendue. Celui-ci a obtenu des résultats fondamentaux en théorie des champs algébriques, en théorie de Gromov-Witten et dans l'étude des invariants de Donaldson-Thomas. Ses travaux de pionnier sur la construction d'une « classe fondamentale virtuelle» ont joué un rôle clé dans l'élaboration des fondements de la théorie de Gromov-Witten. Subséquemment, il a réalisé une percée dans l'étude des invariants de Donaldson-Thomas en montrant que pour certains espaces, le degré la classe fondamentale virtuelle pouvait s'exprimer comme la caractéristique d'Euler topologique pondérée par une fonction naturelle constructible et dépendant seulement des propriétés intrinsèques de l'espace. Cette fonction est maintenant appelée fonction de Behrend. Cela a permis d'utiliser des méthodes motiviques pour calculer les invariants de Donaldson-Thomas ; cela a de plus rendu possible d'obtenir les versions catégorifiées et motiviques de ces invariants, sujet faisant présentement l'objet de beaucoup d'attention. Dans ses travaux antérieurs, le Professor Behrend a obtenu une importante généralisation de la formule de trace de Lefschetz pour les classes algébriques dont la paternité est reconnue en y référant en tant que formule de trace de Behrend. Les idées mises de l'avant par Kai Behrend se sont déjà avérées d'une très grande influence et auront à n'en pas douter un impact durable dans ce secteur des mathématiques.

Kai Behrend a obtenu son PhD en 1991 de la University of California – Berkeley. Il s'est joint à la University of British Columbia en 1994. Le Professeur Behrend a reçu diverses marques de reconnaissance soulignant l'excellence de ses recherches. Celles-ci comprennent le prix Coxeter-James en 2001 et le prix Jeffery-Williams en 2011, tous les deux offerts par la Société Mathématique du Canada. Kai Behrend a aussi été un conférencier invité dans le cadre du Congrès International des Mathématiciens tenu à Séoul en 2014.

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