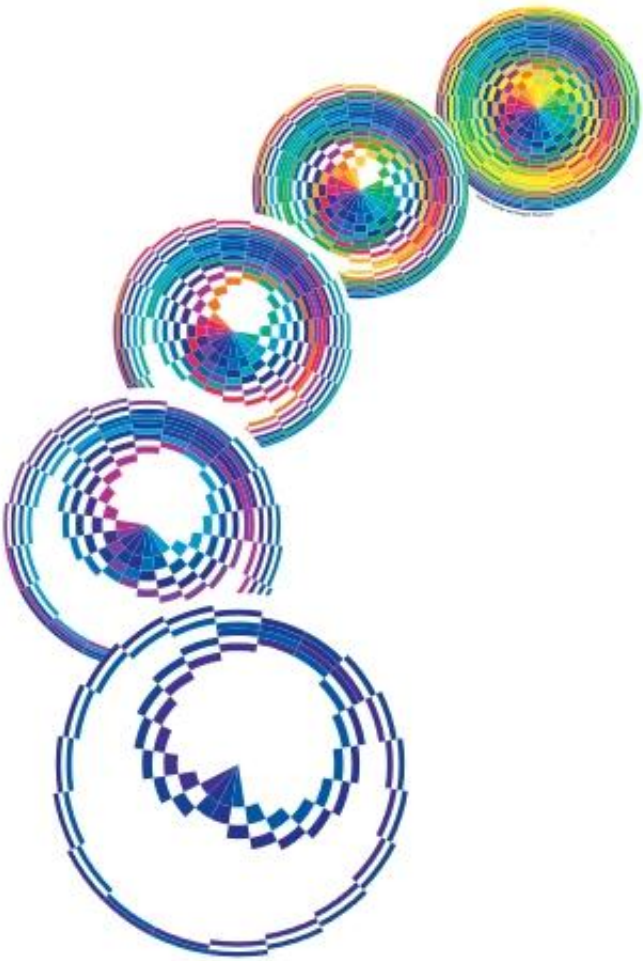
# Atlantic Association for Research in the Mathematical Sciences



# Annual Report 2013

www.aarms.math.ca

# Table of Contents

## *Message from the Director*

In 2013, AARMS continued to promote the mathematical sciences in the Atlantic region. Our programs fostered collaboration at all levels, enabled research groups to increase their activities and profile, and promoted education at all levels. Various applications for renewal of funding to AARMS provided an opportunity to evaluate and showcase our achievements. The year 2013 was also the year of Mathematics of Planet Earth (MPE), which provided an opportunity to highlight an area of research strength in the region and to reach out to the general public.

In 2013, the first generation of Collaborative Research Groups ended their term. This offered a chance to evaluate the impact of the CRG program. The results are encouraging. The Atlantic Algebra Centre has broadened its scope, and now includes algebraists from across the Atlantic region. In addition, the Centre pursued a collaboration with colleagues in Ontario. Members of the CRG in Dynamical Systems are involved in a new PIMS CRG on a similar topic, which plans some collaborative PIMS-AARMS activities. The CRG on Mathematical Ecology and Epidemiology has become part of a pan-Canadian group which was formed as part of the MPE initiative. This group continues its collaboration, and is planning a number of follow-up programs, including another theme year of targeted activities in 2017. Thus, the AARMS CRG program is achieving its goal of raising the profile and increasing opportunities for the research groups involved.

The 2013 AARMS Summer school was held at Memorial University, and was a great success. Four courses were offered on advanced topics in Dynamical Systems and Mathematical Biology. The organizer, Xiaoqiang Zhao, engaged lecturers that are truly the leaders in their field. The theme fit very well with the MPE year, and the summer school was listed as an MPE activity. This enabled students from the US to apply for travel funding, which contributed to the high quality of participants. The school incorporated the suggestions made in the summer school review: an associated workshop on Mathematical Biology was held concurrently, profiting from the presence of the lecturers and adding to the synergy. Also, the participants were surveyed about their experience. The feedback received was overwhelmingly positive.

Two new AARMS Post-doctoral fellows started their two year term this year. The PDF competition again received a high number of excellent candidates. It was a tough job to make a selection of only two out of the large pool of qualified applicants. Post-doctoral fellows bring new energy, new ideas and new connections to their host department. It is of great advantage to the region that AARMS is able to offer post-doctoral fellowships, though the program is oversubscribed. AARMS will continue to

explore ways to increase funding for PDFs in the region, in the hope of increasing their number.

The MPE special year lined up well with several areas of research strength in Atlantic Canada; most notably, mathematical ecology and mathematical biology. The theme year also provided an opportunity to publicize the crucial importance of the mathematical sciences in understanding the various natural processes that rule our planet. This was brought out in a public lecture series, with lectures on the math of weather prediction, ocean waves and tsunamis, and environmental tipping points. The playful side of mathematics was brought out in a number of popular lectures on the interplay between mathematics and art. Most notable of these was the AARMS public lecture by Eric Demaine, which attracted an audience of over 500 people, including many K-12 students.

Finally, in 2013 a number of funding commitments from our sponsors were up for renewal. Preparing the documents for the applications for renewal offered the opportunity to evaluate our programs and sharpen our plans for the coming years. In particular, AARMS participated in the application of CRM, Fields and PIMS to the NSERC-CTRMS program. This proved a worthwhile exercise, which enabled us to better align our programs with those of the other institutes, to strengthen our ties, and to showcase our activities and achievements to our colleagues. We thank CRM, Fields and PIMS for their continued financial support of AARMS. We specifically thank the directors of these institutes for their role in finding opportunities for joint events and projects, and for their guidance.

The year 2013 saw a changing of the guard in the research offices of many of the main universities. I am glad to report that the VPs Research and Deans of the founding universities remain very supportive of AARMS, and I thank them for their help in obtaining provincial funding for AARMS, and in administrating AARMS programs. In addition, AARMS thanks all member universities for their ongoing support. I would also like to thank the department of Mathematics and Statistics at Memorial University and its staff, for the in-kind support for the summer school. Finally, I would like to thank the members of the AARMS Board, the Executive, and the Scientific Review Panel, the summer school directors, and all those involved in organizing our events. Last but not least, I wish to thank David Langstroth, whose help in all aspects of the running of AARMS, but especially in the preparation of the applications for renewal of funding and the organization of the MPE public lectures, has been invaluable.

Jeannette Janssen
AARMS Director
April, 2014

## Collaborative Research Groups

AARMS Collaborative Research Groups consist of Atlantic Province University researchers with common research interests who wish to collaboratively develop their research programs. Members of a CRG typically organize intensive workshops, share PDF appointments, coordinate graduate training programs, propose and assist in AARMS summer school programs, jointly supervise graduate students, and carry out other activities supporting their research programs.

AARMS believes that groups of researchers with common research interests can benefit from sharing resources and coordinating activities. Furthermore, CRGs offer young researchers a larger community for growing their research program. AARMS also believes that the critical mass achieved by CRGs will help the Atlantic Provinces to recruit and retain faculty in mathematical sciences, to attract post-doctoral fellows and offer enhanced training programs attracting more graduate students.

In 2013 the first generation of AARMS CRGs completed their two year term. They were: The Atlantic Algebra Centre, The Collaborative Research Group in Dynamical Systems and The Collaborative Research Group in Mathematical Ecology and Epidemiology. The Atlantic Algebra Centre continues as an AARMS Centre, and is pursuing a collaboration with the Network of Ontario Lie Theorists. The leader of the CRG on dynamical systems is now part of the organizing committee of a PIMS CRG on “Applied Partial Differential Equations and Pattern Formation”. This CRG plans an number of PIMS-AARMS collaborative activities. James Watmough, leader of the AARMS CRG on Mathematical Ecology and Epedimiology, is planning to start a centre for mathematical biology. The members of this former CRG are part of a nationwide network of specialists in mathematical biology.

Another group of CRGs began their two-year terms starting in September. They were: The Atlantic Collaborative Research Group in Numerical Analysis and Scientific Computing, Statistical Modeling of Complexly Correlated Data, and Graphs and Games.

## The Atlantic Algebra Centre (AAC)

Members:

Yuri Bahturin (Memorial)
Margaret Beattie (Mount Allison)
Evgeny Chibrikov (Memorial)
Sara Faridi (Dalhousie)
Edgar Goodaire (Memorial)
Alexei Gordienko (Memorial)
Colin Ingalls (new Brunswick)
John Irving (St. Mary's)
Mikhail Kotchetov (Memorial)
Eduardo Martinez-Pedroza (Memorial)
Mitja Mastnak (St. Mary's)
Mike Parmenter (Memorial)

Roman Smirnov (Dalhousie)
Hugh Thomas (New Brunswick)
Hamid Usefi (Memorial)
Yiqiang Zhou (Memorial)

The Atlantic Algebra Centre came into existence on September 1, 2006, and has been funded as an AARMS Collaborative Research Group since 2011. The goal is to promote research in Algebra and applications in the Atlantic Provinces of Canada, with Memorial University of Newfoundland (MUN) as the central location. The work of the Atlantic Algebra Centre is overseen by an Advisory Board of eminent mathematicians: Yuri I. Manin (Director of the Max Planck Institute for Mathematics in Bonn and Trustee Chair and Professor of Mathematics at Northwestern University), Sudarshan K. Sehgal (Professor of Mathematics at the University of Alberta and academic father and grandfather of many Canadian algebraists) and Efim Zelmanov (Fields Medalist, Member of the National Academy of Sciences of the United States of America and Rita Atkinson Chair of Mathematics at the University of California - San Diego). The Atlantic Algebra Centre Graduate Prizes for 2012/2013 were awarded to Mr Ali Alilooee and Ms Emma Connon from Dalhousie University (supervisor - Dr Sara Faridi). They were awarded research support in the amount $750 each.

Mini Courses:

**Combinatorial Group Theory** - given by Professor Mark Sapir (Vanderbilt University), March 4-7, 2013.

Workshops and Seminars:

International Workshop in Combinatorial Algebra, held at Dalhousie and St. Marys in Halifax, June 1-6, 2013

*Participants at the International workshop in Combinatorial Algebra*

Most Significant Publications:

Brav, C.; Thomas, H., Thin monodromy in Sp(4), with Chris Brav, Compositio Mathematica, 2013, 13 pp, http://dx.doi.org/10.1112/S0010437X13007550

Elduque, A.; Kochetov, M., Graded modules over classical simple Lie algebras with a grading, Israel Journal of Mathematics, 38 pp.

Goodaire, E.; Polcino Milies, C., Oriented involutions and skew-symmetric elements in group rings, J. Alg. Apps, v. 12 (2013), no.1, 10pp., DOI: 10.1142/S0219498812501319

Martinez-Pedrosa, E.; Wise, D. Coherence and negative sectional curvature in complexes of groups, Michigan Math. J., v. 62 (2013), pp. 507-536

Tang, G.; Zhou, Y., A class of formal matrix rings, Linear Algebra and Its Applications, v. 438 (2013), pp. 4672–4688.

## *The Collaborative Research Group in Dynamical Systems*

Members:

Johan Brannlund (Cape Breton)
Alan Coley (Dalhousie)
David Iron (Dalhousie)
Theodore Kolokolnikov (Dalhousie)
Ryan Lukeman (St. F.X.)
Robert van den Hoogen (St. F.X.)

Dynamical systems is a very active field of study. It encompasses many applications to such diverse fields as cosmology, population dynamics and cell biology, to give just a few examples. Many advanced techniques from all areas of mathematics are often brought to bear on these and other problems; the interaction between dynamical systems and underlying applications often yields unexpected insights in either mathematics or its application. A collaborative research group in dynamical systems represents a timely and exciting opportunity with many potential benefits to a wide group of researchers throughout the Atlantic provinces.

The majority of the resources were spent on student salaries for the undergraduate research programme (MUSE: Mathematics undergraduate summer research experience). The remainder was spent on visitors to Dalhousie as well as the Math Biology workshop organized by David Iron at Dalhousie. Overall, the CRG attracted over $1.5 from outside funding for every $1 from AARMS. The following organizations contributed to the Dal MUSE program: UCLA: Summer REU in applied math ran by Andrea Bertozzi); NSERC: (Iron, Coley, Kolokolnikov, van den Hoogen); Faculty of Medicine, geriatrics: (Mitninski); Rowe's school of business trust: (John Rumsey).

The summer program involved seven undergraduate students from Dal and one from StFX working with six faculty members (four from math, one from medicine, one from finance) on numerous problems ranging from from cosmology to medical data. As part of this program, two of these students and one faculty member spent the summer at UCLA, participating in the undergraduate summer research program in mathematics under the auspices of NSF. The students got to experience first-hand what it takes to do research. There are at least three papers in the making as a direct result of the student's involvement; one conference proceeding was already accepted.

*Participants of UCLA REU on analysis of medical data.*

*Left to right:*
*Blake Hunter (mentor, UCLA),*
*Paul Chavy-Waddy (Dalhousie)*
*John Wu (UCLA)*
*Mindy Chase (UCLA),*
*Theodore Kolokolnikov (mentor, Dalhousie)*

Most Significant Publications:

A. Dawes, D. Iron, Cortical geometry may influence placement of interface between Par protein domains in early Caenorhabditis elegans embryos, J. Theor. Bio.,333, pp 27-37, (2013)

C. Levy, D. Iron, Dynamics and stability of a three-dimensional model of cell signal transduction, J. Math. Bio., 67, pp 1691-1728 (2014)

Logarithmic Expansions and the Stability of Periodic Patterns of Localized Spots for Reaction-Diffusion Systems in R^2 with D. Iron, J. Rumsey, and J. Wei, (accepted, J. of Nonlinear Science, (2014), 41 pages).

Spherically symmetric Einstein-aether Cosmological Models, 2014, A. A. Coley, G. Leon and P. Sandin, preprint

I. A. Brown, A. A. Coley, D. L. Herman and J. Latta, 2013, On the physical effects of consistent cosmological averaging}, Phys. Rev. D 88, 083523 [arXiv:1308.5072].

B. Alhulaimi, A. Coley and P. Sandin, 2013, Anisotropic Einstein-Aether Cosmological models}, J. Math. Phys. 54, 042503 (29 pages).

Alan Mackey, Theodore Kolokolnikov and Andrea L. Bertozzi, Two-species particle aggregation and stability of co-dimension one solutions. , submitted, DCDS Papers

Yuxin Chen and Theodore Kolokolnikov, A minimal model of predator-swarm dynamics, Journal of the Royal Society Interface 11:20131208 (2014)

T. Kolokolnikov, J. Wei, and A. Alcolado, Basic mechanisms driving complex spike dynamics in a chemotaxis model with logistic growth, to appear, SIAM J.Appl.Math.

T. Kolokolnikov and Alan Lindsay, Recovering multiple small inclusions inside an a three dimensional domain using a single measurement , to appear, Inverse Problems in Science & Engineering.

Theodore Kolokolonikov, Jose Carrillo, Andrea Bertozzi, Razvan Fetecau and Mark Lewis, Introduction to Physica D special issue on Emergent behaviour in multi-particle systems with non-local interactions , Physica D Vol.260, pp.1-4 (2013)

## *The Collaborative Research Group in Mathematical Ecology and Epidemiology*

Members:

Lin Wang (New Brunswick)
James Watmough (New Brunswick)
Andy Foster (Memorial)
Chunhua Ou (Memorial)
Yuan Yuan (Memorial)
Xiaoqiang Zhao (Memorial)
Frithjof Lutscher (Ottawa)
Xingfu Zou (Western Ontario)
Wendi Wang (Southwest U., China)

The AARMS CRG in Mathematical Ecology and Epidemiology started in September of 2011 and was funded for two years. In the first year, funding from AARMS was used predominantly for visitors to the group and was split roughly equally between research visits and a minicourse. The CRG's second year coincided with the Mathematics of Planet Earth launch. Since the focus of the AARMS summer school was on mathematical biology, it was felt that a minicourse was not needed. Instead, the CRG used funds to support two visitors, travel between nodes, and students.

Centre members met and presented at two international workshops held in the region: the Fifth Annual AARMS workshop on mathematical Biology held at Memorial University, and the AARMS-CRM workshop on sustainability of aquatic ecosystem networks held in Fredericton, NB.

In both years, the funding made possible an increase in the number of visits to the group and fostered research that would not have been possible without the CRG funds.

Academic Visitors:

The centre had two academic visitors in 2012/2013.

- Junyuan Yang (Yuncheng University, China)
- Binxiang Dai (Central South University, China)

Funding for these visitors came from several sources, including departmental seminar funds, NSERC discovery grants and the AARMS CRG funding.

Presentations

Binxiang Dai, Global dynamics and optimal harvesting of two competing species with interval biological parameters, 19 July, 2013.

Junyuan Yang, Global stability of an SIRS model with infection age, 23 August, 2013

Isam Al-darabsah, Dynamics on a General Stage Structured n Parallel Food Chains, BIOMAT 2013 International Symposium on Mathematical and Computational Biology, Nov. 4-8, 2013, Fields Institute, Toronto.

Most Significant Publications:

H. Shu and L. Wang, Global stability and backward bifurcation of a general viral infection model with virus-driven proliferation of target cells, DCDS-B (accepted)

H. Shu, L. Wang and J. Watmough, Sustained and transient oscillations and chaos induced by delayed antiviral immune response in an immunosuppressive infection model, J. Math. Biol. 68(2014), 477-503.

H. Shu, L. Wang and J. Wu, Global dynamics of Nicholsons blowflies equation revisited: Onset and termination of nonlinear oscillations, J. Diff. Equations, 255(2013), 2565-2586.

## *The Atlantic Collaborative Research Group in Numerical Analysis and Scientific Computing*

Members:

Ronald Haynes (Memorial)
Paul Muir (St. Marys)
Hermann Brunner (Memorial)
Hans de Sterck (Waterloo)
Jean-Christophe Nave (McGill)
Martin Gander (Geneva)
Weizhang Huang (Kansas)
Colin Farquharson (Memorial)
Shaohua Chen (Cape Breton)
Jahrul Alam (Memorial)
Richard Karsten (Acadia)

This group, under the administration of Ronald Haynes, started in September 2013 and has yet to report on its first year. It will provide a focal point for activity in pure numerical analysis and the many ongoing collaborative initiatives with earth scientists, geophysics, oceanographers and petroleum engineers. The mission of the group is to:

- concentrate the considerable existing expertise to tackle active research questions concerning the design, analysis and implementation of numerical algorithms particularly suited to today's (and tomorrow's) multi--core computing infrastructures,
- to give the discipline a larger profile regionally and nationally -- attracting students, facilitating the training of highly qualified personnel and knowledge transfer, and engaging scientists and engineers to collaborate with us to solve the increasingly complex applied problems,
- and to provide a catalyst for growth of numerical analysis and scientific computing within our institutions and the region.

## *Statistical Modeling of Complexly Correlated Data with Applications*

Members:

Renjun Ma (UNB)
M. Tariqul Hasan (UNB)
Guohua Yan (UNB)
Jeff Picka (UNB)
Claire Goggin (St. Thomas)
Zhaozhi Fan (Memorial)
Ying Zhang (Acadia)
Gary Sneddon (Mount St Vincent)
Henrik Stryhn (UPEI)
Yanqing Yi (Memorial)

This group, under the administration of Renjun Ma, started in September 2013 and has yet to report on its first year. Its objectives are: i) to address emerging statistical problems and challenges in the analysis of data of complex correlation structures; ii) to facilitate interactions between methodological researchers and applied statisticians or subject-area researchers; iii) to bring together researchers in the areas to exchange ideas and problems, and to collaborate; iv) to discuss directions of future research in this areas and software developments; v) to encourage graduate students and new researchers to work in this exciting area; vi) to facilitate joint supervision of undergraduate, graduate students and postdoctoral fellows; viii) to facilitate student exchanges and training.

## *Graphs and Games*

Members:

Richard Nowakowski (Dal)
Suzanne Seager (Mount St Vincent)
Margaret-Ellen Messinger (Mt Allison)
Jeannette Janssen (Dal)
Bert Hartnell (St Marys)
Shannon Fitzpatrick (UPEI)
Stephen Finbow (STFX)
Art Finbow (St Marys)
Danny Dyer (Memorial)
Nancy Clarke (Acadia)
Jason Brown (Dal)

This group, under the administration of Richard Nowakowski, started in September 2013 and has yet to report on its first year. The core of this groups interests is the interaction of graphs and disciplines outside of graph theory, and the structures that arise. A major emphasis is on interactions that have a dynamical aspect:

(a) Dynamical problems

(b) Vector Spaces, Independent sets and Graphs

(c) Polynomials arising from graphs

(d) Evolution of large-scale graphs

(e) Games on Graphs

## *AARMS Summer School*

The twelfth AARMS Summer School took place at the St. John's campus of Memorial University of Newfoundland from July 15 to August 9, 2013 under the direction of Xiaoqiang Zhao. As usual, four courses at the beginning graduate level were offered in Dynamical Systems and Mathematical Biology, all under the theme of "The Mathematics of Planet Earth, 2013":

- **Stochastic Modeling with Applications in Biology**
  Drs. Linda Allen and Edward Allen, Texas Tech University, USA
- **Reaction-Diffusion Equations and Applications**
  Dr. Stephen Cantrell, University of Miami, USA
- **Mathematical Methods to Gain Biological Insights**
  Dr. Odo Diekmann, Utrecht University, The Netherlands
- **Mathematical Modelling in Developmental Biology and Medicine**
  Dr. Philip Maini, University of Oxford, UK

Instructor Bios:

**Edward Allen** is a professor of mathematics at Texas Tech University. He graduated with a Ph.D. degree in mathematics from the University of Tennessee in 1983. Before receiving his doctoral degree in mathematics, he obtained B.S. and M.S. degrees in nuclear engineering from the University of Wisconsin and worked as a professional nuclear engineer at Oak Ridge National Laboratory.
Edward Allen performs research in model formulation, analysis, and computation of deterministic and stochastic models in biology, nuclear engineering, and physics with over 70 papers in technical journals. He has directed twenty-six MS theses and six PhD dissertations. He is the author or co-author of two graduate texts "Modeling with Ito Stochastic Differential Equations" and "Classical and Modern Numerical Analysis". In addition to regularly teaching graduate courses in stochastic differential equations (SDEs) and numerical analysis at Texas Tech University, he has given workshops in the derivation and computation of stochastic differential equation models at the National Center for Theoretical Sciences at the National Tsing Hua University in Taiwan, the MAA Professional Enhancement Program at Texas Tech University, the Mathematical Biosciences Institute at Ohio State University, and the National Institute for Mathematical and Biological Systems at the University of Tennessee. He is scheduled in the summer of 2013 to present an intensive course in SDEs for the Atlantic Association for Research in Mathematical Sciences at the Memorial University of Newfoundland.

**Linda J. S. Allen** is a professor of mathematics at Texas Tech University. She received her M.S. and Ph.D. degrees in mathematics from the University of

Tennessee. Her research interests include mathematical modeling of biological systems, applying discrete and continuous dynamical systems and stochastic processes to problems in epidemiology, population biology, immunology, and plant pathology. She is the author of two textbooks, An Introduction to Mathematical Biology and An Introduction to Stochastic Processes, and over 80 papers in mathematical biology. She has directed or co-directed 39 M.S. and PhD theses and 9 undergraduate research projects. Professionally, she serves on the editorial board for Mathematical Biosciences, Journal of Theoretical Biology, Journal of Difference Equations and Applications and Journal of Biological Dynamics. Over the past 8 years, Linda Allen has given invited lectures on deterministic and stochastic models in epidemiology and population biology at workshops and short courses held at Banff Research Station, York University, and University of Alberta in Canada, National Tsing Hua University in Taiwan, Universidade de Porto in Portugal, and Mathematical Biosciences Institute, Ohio State University and National Institute for Mathematical and Biological Synthesis, University of Tennessee, in the United States.

**Stephen Cantrell** received his B.S. in mathematics summa cum laude from Furman University in 1976 and his Ph.D. in mathematics from the University of Utah in 1981, under the supervision of Klaus Schmitt. After one year at Southwest Texas State University in San Marco, Texas, he joined the faculty of the Department of Mathematics at the University of Miami in the fall of 1982 as an Assistant Professor, rising to the rank of Associate Professor in 1987 and to the rank of Professor in 1992. Since 2007 he has served as Director of the University of Miami Institute of Theoretical and Mathematical Ecology. He currently is an Associate Editor of Mathematical Biosciences and Engineering. Cantrell's areas of mathematical specialization are nonlinear analysis, partial differential equations, and mathematical ecology and epidemiology. Cantrell's 30 year plus collaboration on these topics with his Miami colleague Chris Cosner has led to over 60 joint papers, the book Spatial Ecology via Reaction-Diffusion Equations (John Wiley and Sons 2003) and the recent volume of essays Spatial Ecology (co-edited with Shigui Ruan also of the University of Miami) (CRC/Chapman Hall 2009). Much of this work has also been in conjunction with the research groups of Yuan Lou at Ohio State University, William Fagan at the University of Maryland and John Beier of the Miller School of Medicine at the University of Miami. Cantrell's current research interests include the ecological effects and evolution of dispersal, the ecological foundations of the establishment of vector-borne disease in arid environments, and the interplay of phenology, asynchronous demography and dispersal and evolutionary adaptation in the face of climatic change.

**Odo Diekmann** worked at the CWI in Amsterdam from 1974 to 1995, obtaining his PhD degree at the University of Amsterdam in 1978. From 1986 to 1995 he was part time professor in Mathematical Biology at the University of Leiden, where he collaborated closely with Hans Metz. In 1995 he became professor of Applied Mathematics at Utrecht University. His fields of interest are Population Dynamics (including Infectious Disease Epidemiology and Evolution) and Dynamical Systems

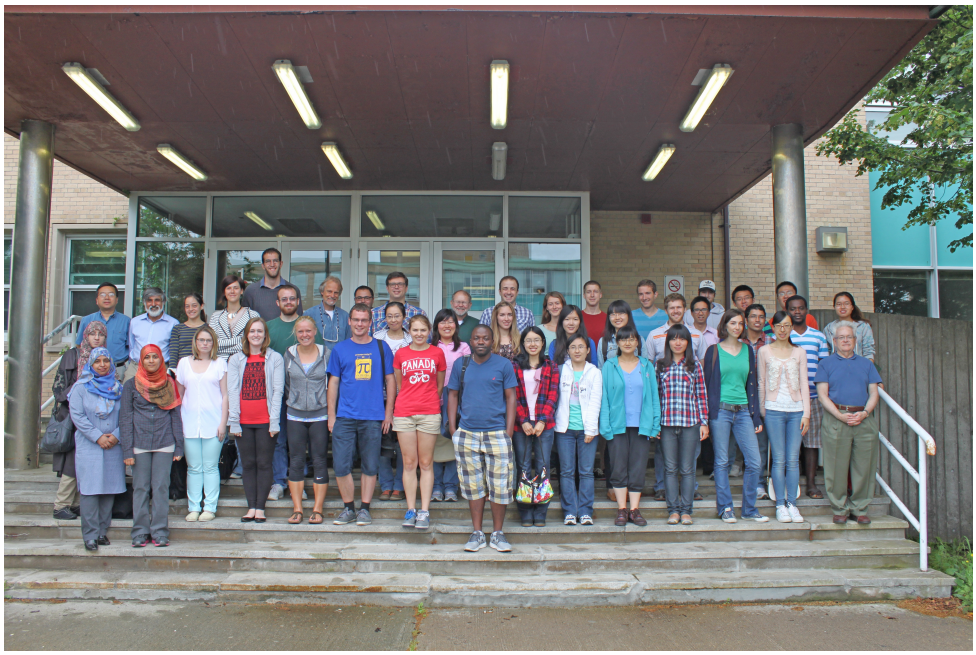
(notably delay equations). He is a Honorary Editor of the Journal of Mathematical Biology and has written, jointly with others, various books. The most recent of these MATHEMATICAL TOOLS FOR UNDERSTANDING INFECTIOUS DISEASE DYNAMICS (together with Hans Heesterbeek and Tom Britton) just appeared at Princeton University Press.

**Philip K. Maini** received his B.A. in mathematics from Balliol College, Oxford, in 1982 and his DPhil in 1985 under the supervision of Prof J.D. Murray, FRS. After completing his studies he spent a year as an Assistant Master at Eton College before returning to the CMB in 1987 as a Junior Research Fellow at Wolfson College, Oxford. In 1988 he was appointed Assistant Professor in the Mathematics Department at the University of Utah, Salt Lake City before returning to Oxford two years later, initially as a University Lecturer and then as Professor and Director of the CMB. He is currently on the editorial boards of a large number of journals, including serving as the Editor-in-Chief of the Bulletin of Mathematical Biology. He has also been an elected member of the Boards of the Society for Mathematical Biology (SMB) and European Society for Mathematical and Theoretical Biology (ESMBTB). He is a Fellow of the IMA, a SIAM Fellow, and was elected Miembro Correspondiente, La Academia Mexicana de Ciencias (AMC) in 2011. His present research projects include the modelling of avascular and vascular tumours, normal and abnormal wound healing, and a number of applications of mathematical modelling in pattern formation in early development, as well as the theoretical analysis of the mathematical models that arise in all these applications. He has over 300 publications in the field and has held visiting positions at a number of universities worldwide. He was a Distinguished Foreign Visiting Fellow, Hokkaido University (2002). In 2005 he was elected Honorary Guest Professor, University of Electronic Science Science and Technology of China, Chengdu, in 2006 appointed to a 3-year Adjunct Professorship at the School of Mathematical Sciences, Queensland University of Technology, Brisbane (and again in 2012), in 2010 appointed to a 3-year Adjunct Professorship at Lincoln University, Christchurch, New Zealand, and also appointed as a Distinguished Research Fellow at the African Institute for Mathematical Sciences (AIMS), South Africa. He co-authored a Bellman Prize winning paper (1997), was awarded a Royal Society Leverhulme Trust Senior Research Fellowship for 2001-2 and a Royal Society-Wolfson Research Merit Award (2006-11). In 2009 he was awarded the LMS Naylor Prize and Lectureship.

Altogether, 44 students and two postdoctoral fellows enrolled in courses, typically two each. Five students were from Atlantic-Canadian universities, with 10 more from elsewhere in Canada. Other students came from China, France, Portugal, Switzerland, Germany, Italy, Poland and the USA. The Summer School courses pushed students to extend the concepts via-out-of class projects, which encouraged a collaborative environment. Students were able to seek each other out in order to discuss possible ideas and perspectives and, due to the vast array of backgrounds

present, they were able to see that working with biologists, ecologists, and other bio-mathematicians can lead to a better understanding of the topics at hand.

While participating in the summer school, students also had the opportunity to attend the 2013 AARMS Mathematical Biology Workshop that took place at Memorial University from July 27- 29. The workshop was organized by Drs. Amy Hurford and Xiaoqiang Zhao and featured several parallel sessions and seven plenary lectures. Including the summer school students, there were 84 attendees from Europe, Canada, the United States, and Asia.



Participants at the 2013 AARMS Summer School

List of Students

| | | |
|---|---|---|
| Yusuf Alagöz | Izmir Institute of Technology | Turkey |
| Sarah Aljaryan | Memorial University of Newfoundland | Canada |
| Dilara Altan | Izmir Institute of Technology | Turkey |
| Kathleen Barnetson | University of Victoria | Canada |
| Aryan Bayani | Université de Montréal | Canada |
| Giuliano Bianco | University of Ferrara | Italy |
| Ruqian Chen | Amherst College | USA |
| Micha l Eckstein | Jagiellonian University | Poland |
| Aysel Erey | Dalhousie University | Canada |

| | | |
|---|---|---|
| Nursel Erey | Dalhousie University | Canada |
| Aras Erzurumluo§glu | Auburn University | USA |
| Nevena Francetic | University of Toronto | Canada |
| Adam Gardner | Memorial University of Newfoundland | Canada |
| Weichen Gu | University of Michigan | USA |
| Sadegheh Haghshenas | Memorial University of Newfoundland | Canada |
| Gaelan Hanlon | University of New Brunswick | Canada |
| Isam Al-Darabsah | Memorial University of Newfoundland | Canada |
| Bassemah Alhulaimi | Dalhousie University | Canada |
| Sa¯a Athar | University of Guelph, | Canada |
| Andrew Blanchard | University of Illinois at Urbana-Champaign | USA |
| Spencer Carran | Pennsylvania State University | USA |
| Xiaoyan Chen | Hunan University | China |
| Weiwei Ding | University of Marseille | France |
| Marina Ferreira | University of Coimbra | Portugal |
| Maria Florescu | University of Basel | Switzerland |
| Andrew Philip Foss-Grant | University of Maryland | USA |
| Paquin-Lefebvre Frederic | University of Montreal | Canada |
| Kelsey Gasior | North Carolina State University | USA |
| Jessica Hearns | University of Central Florida | USA |
| Zhe Huang | China Jiliang University | China |
| Xi Huo | Vanderbilt University | USA |
| Xiulan Lai | University of Western Ontario | Canada |
| Surya Lamichhane | Wilfrid Laurier University, | Canada |
| Fang Li | University of Science and Technology of China | China |
| Xiangyi Li | Max Planck Institute for Evolutionary Biology | Germany |
| Yubin Liu | South China Normal University | China |
| Philip McDowall | State University of New York at Stony Brook | USA |
| Evan Michael Milliken | University of Florida | USA |
| Michael E. M. Ngouma | University of Ottawa | Canada |
| Laine Noble | Ohio State University | USA |
| Laurel AnnaMarie Ohm | University of Alberta | Canada |
| Sonia Pozzi | Insubria University | Italy |
| Emmanuel K. A. Quansah | Clarkson University | USA |
| Julie Rose | Memorial University of Newfoundland | Canada |
| Douglas Bruce Staple | Dalhousie University | Canada |
| Amanda Catherine Swan | University of Alberta | Canada |
| Xiaodong Tai | University of Science and Technology Beijing | China |
| Xiaoying Wang | University of Western Ontario | Canada |
| Alison Wardlaw | University of Toronto | Canada |
| Easton White | Arizona State University | USA |
| Xiao Yu | Memorial University of Newfoundland | Canada |
| Tingting Zhao | University of Ottawa | Canada |
| Yi Zhu | University of Central Florida | USA |
| PaweÃl Zwolenski | Polish Academy of Sciences | Poland |

In a survey of participants taken after the summer school had finished, respondents gave scores to the four different courses. Average scores ranged between 80% and 95%. Ratings of lecturers ranged between 77% and 96%. When asked whether they would recommend the summer school to a friend or colleague, 96% or respondents said that they would. The following comment was typical:

> *"Thanks for this opportunity! It had been a good idea if there were some activity at the beginning to let everyone (students and teachers) know each other. But everything was perfect! Congratulations for the organization!"*

The thirteenth annual Summer School will be held July 21 to August 15, 2014 at Dalhousie University. We will be offering the following courses:

- **Gröbner Bases in Commutative Algebra**
  Dr.Giulio Caviglia , Purdue University

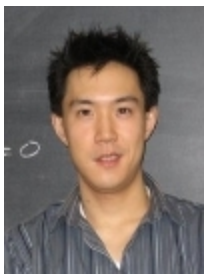
- **Homological Conjectures in Commutative Algebra**
  Dr. Hailong Dao , University of Kansas

- **Statistical Learning with Big Data**
  Drs. Hugh Chipman, Acadia University and Xu (Sunny) Wang, St. Francix Xavier University

- **Spatial Statistics**
  Dr. Julie Horrocks, University of Guelph

## *AARMS Postdoctoral Fellowship Program*

In 2013 two new AARMS Postdoctoral Fellowships were awarded:



**Justin Tzou** received his PhD in 2012 in Applied Mathematics from Northwestern University. He currently works at Dalhousie University under the supervision of Theodore Kolokolnikov. His research is in the formation and stability of patterns in different regimes of reaction-diffusion equations using weakly nonlinear, asymptotic, and numerical methods.

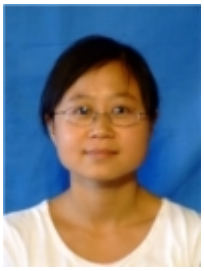
**Yuzhao Wang** received his PhD (2010) in Pure Mathematics from Peking University, Beijing, China. As an AARMS postdoctoral fellow, he is currently working at Memorial University under the supervision of Prof. Jie Xiao. His research interests lie in Harmonic Analysis and Partial Differential Equations.

Other AARMS Postdoctoral Fellowships held in 2013:

**Rogers Mathew** received his Master of Engg. degree (2007) and PhD(2012) in Computer Science from the Indian Institute of Science, Bangalore, India. He worked as an ARMS PDF at the University of Dalhousie under the supervision of Prof. Jeannette Janssen. His research interests are in graph theory and combinatorics. Rogers finished his term as a postdoc in 2013 and currently holds a post-doctoral position at the University of Haifa, Israel

**Charles Paquette** received his Ph.D. in 2010 at the Université de Sherbrooke, Quebec, Canada. As an AARMS postdoctoral fellow, he is working at the University of New Brunswick under the supervision of Drs Hugh Thomas and Eddy Campbell. His research interests focus on representation theory of associative algebras. His last projects dealt with Auslander-Reiten theory, representation theory of infinite quivers, homological conjectures and semi-invariants of quivers.

**Douglas Stones** received his PhD (2010) in Pure Mathematics from Monash University, Melbourne, Australia. He is currently working at Dalhousie University together with Prof. Jeannette Janssen on graphs, including both theoretical and real-world research.



**Hongying Shu** received her PhD from Harbin Institute of Technology (China) in 2010. She worked as an AARMS PDF at the University of New Brunswick under the supervision of Lin Wang and James Watmough. Her research focuses on modeling, analysis and simulations of models in biology, epidemiology, immune system, and gene and neural networks.

**Ryan Tifenbach** received his PhD from the Hamilton Institute, National University of Ireland, Maynooth, under the supervision of Steve Kirkland. He worked with Danny Dyer at Memorial University as an AARMS Postdoc. His research interests include combinatorics and linear algebra, with a special focus on eigenvalues and graphs.

**Francis Valiquette** obtained his Ph.D. in 2009 from the University of Minnesota and from 2009-11 he was an NSERC of Canada Postdoctoral Fellow at McGill University. As an AARMS PDF he worked under the guidance of Professor Robert Milson at Dalhousie University. His research deals with the theory and applications of transformation groups and their invariants to problems coming from geometry and mathematical physics. Francis finished his fellowship in 2013 and is now a faculty member at SUNY, New Platz.

The competition for 2014 positions opened in November 2013 with final decisions on awards made in spring 2014. We have the budget to offer two Postdoctoral positions in 2014.

Past holders of AARMS Postdoctoral Fellowships have gone on in many cases to continue in successful careers in mathematics.

**Past Postdoctoral Fellows:**

Evgeny Chibrikov, Memorial 2009-11 – Currently working in industry in St. John's
Alin Ciuperca, *UNB 2009-11* – Currently working in the Financial sector in Toronto
Kia Dalili, *Dalhousie 2005-07* - Currently working at the Stevens Institute of Technology in Hoboken,New Jersey
Mahya Ghandehari, *Dalhousie 2010-12* - Currently Assistant Professor, U. of Saskatchewan
Alexei Gordienko, *Memorial 2010-12* - Currently working as a Marie Curie Postdoctoral Fellow at Vrije Universiteit in Brussels
Thomas Guedenon, *Mount Allison 2003-05* – no information
Rebecca Hammond, *Acadia 2007-09* - no information
Sigbjorn Hervik, *Dalhousie 2005-06* - Currently a full professor at the University of Stavanger in Norway.
Daniel Horsley, *Memorial 2008-10* – Currently ARC DECRA Research Fellow in the School of Mathematical Sciences at Monash University
Golam Hossain, *University of New Brunswick 2008-10* – Currently Assistant professor at the Indian Institute of Science and Education in Kolkata.
Tobey Kenney, *Dalhousie 2006-08* - Currently Professor of mathematics at Dalhousie
Dawood Kothawala, *University of New Brunswick 2010-12* – Currently Assistant professor at the Indian Institute of Techology (IIT) in Madras.
Peter LeFanu Lumsdaine, *Dalhousie 2010-12* - Currently holds a postdoctoral position at the Institute of Advanced Studies in Princeton
Ping Wong Ng, *University of New Brunswick 2003-05* – Currently Assistant professor in the Mathematics Department at the University of Louisiana at Lafayette
Rui Peng, *Memorial 2010-12* - Currently is a postdoc in the Institute of Math. and its Applications,
University of Minnesota.
Michael A. Warren, *Dalhousie 2010-11* - Currently holds a postdoctoral position at the Institute of Advanced Studies in Princeton
Oliver Winkler, *University of New Brunswick 2004-06* - Currently Strategic Analyst with Siemens Canada
Dansheng Yu, *Saint Francis Xavier 2006-08* – Currently Associate Professor, Hangzhou Normal University, China

## *Conferences and Workshops*

In 2013 AARMS funded or partially funded the following workshops conferences and events. These involved over 1500 participants, more than 1100 of whom were from outside Atlantic Canada:

**Events with Funding from External Sources:**

**Statistical Society of Canada Annual Meeting 2013**
Organizer: Tim Swartz et al
Location: University of Alberta, Edmonton
Date: May 26-29, 2013

The 2013 annual meeting of the Statistical Society of Canada (SSC) was held at the University of Alberta from May 26 through May 29. The meeting was very successful attracting 489 participants from academia and industry. Regional participants from Atlantic Canada included R Agarwal, K Alobaidan, A Alsubie, N Cadigan, H Chipman, A Corkum, J de Tibeiro, C Field, V Gadag, D Hamilton, B MacDonald, A Oyet, J Picka, P Ranjan, B Smith, N Spencer, C van Bommel, Y Zhang and L Zou. Of the 489 participants, there were 103 students in attendance. On the first day of the conference (Sunday), three concurrent full-day workshops were held: Biostatistics (65 participants), Business and Industrial Statistics (10 participants) and Probability (10 participants). On the same evening, a public lecture was also held. The second through fourth days of the conference consisted of scientific sessions. In total, 47 invited paper sessions were held. In addition, there were 31 contributed paper sessions, two case studies sessions and a poster session. There were many simultaneous sessions but one of the highlights was the Gold Medal Address given by Robert Tibshirani of Stanford University. This was of great scientific interest and importance to the Statistics community, involving an introduction to theoretical results for the lasso, a modern computational approach to regression involving many variables. Distribution theory for lasso procedures have previously remained elusive, and Professor Tibshirani illustrated how his team and others were working on asymptotic testing procedures related to the lasso and other computational techniques.
Also funded by CRM, Fields PIMS, CIHR, Alberta Innovates, Women & Children's Health Research Institute, and the City of Edmonton

**CanaDAM Conference**
Organizers: D. Pike, F. Ruskey, B. Stevens, G. MacGiillivray, O. Marcotte, L. Stewart, D. Panario
Location: Memorial University, St. John's
Date: June 10-13, 2013

CanaDAM 2013 (Canadian Discrete and Algorithmic Mathematics Conference) was held on the St. John's campus of Memorial University during June 10-13, 2013. The meeting hd 285 registered participants of which 110 were students. At least 28 different countries were represented as well as all 10 Canadian provinces. The program consisted of 8 plenary talks, 9 invited minisymposia with a total of 45 talks, 28 contributed minisymposia with total of 136 talks, and 74 contributed talks which were not part of a minisymposium. Plenary speakers were Carla Savage (North Carolina), Victor Reiner (Minnesota), Robert Sedgewick (Princeton), Miguel Anjos (École Polytechnique), Reinhard Diestel (Hamburg), Anne Condon (UBC), Benny Sudakov (UCLA) and Cheryl Praeger (Western Australia). In addition to these plenary talks there was a well received 1-hour popular lecture on Opt Art (art constructed with the assistance of omptimisation techniques) givenby Robert Bosch (Oberlin). Furthermore, Brett Stevens (Carleton) hosted a problem session devoted to the presentation of research problems appropriate for graduate students. It is worthwhile to note the breadth of mathematics, applications and theoretical computer science that is represented at this conference. For example, there were talks and minisymposia on finite fields, algebraic combinatorics, geometric graph theory, Galois geometries, analytic combinatorics, graph theory, combinatorial optimisation, complexity theory, data structures, probabilistic combinatorics and computational biology.
Also funded by CMS, CRM, Fields and PIMS

**Canadian Undergraduate Math Conference**
Organizers: Kevin Gervais et al
Location: Université de Montréal
Date: July 10-14, 2013

The Canadian Undergraduate Math Conference took place at the Université de Montréal July 10-14, 2013. It offered a unique opportunity for students to acquire a first exposure to current research in different mathematical fields. Through seminars and social activities, the CUMC also provided a venue for students to connect with other students from across Canada – connections students can benefit from throughout their mathematical career. Furthermore, the event promoted different fields within mathematics, and offered a unique opportunity for students to meet active researchers working in applied fields, such as physics, economics, informatics,

statistics, engineering, and actuarial science. The conference brought together more than two hundred students from various academic backgrounds. Each student had the opportunity to present a topic they found interesting. It is a rewarding experience for talented young mathematicians to go beyond the typical undergraduate experience and meet to discuss their common interests with like minded students. It is a non-competitive event in order to best facilitate the exchange of ideas and encourage diversity, which is essential for the development of mathematics across the country.
Also funded by CMS, CRM, Fields, PIMS, CSEC, ASSQ, SSC and iMETRIC

**2013 AARMS Workshop in Mathematical Biology**
Organizers: Amy Hurford, Xiaoqiang Zhao
Location: Memorial University, St. John's
Date: July 27-29, 2013

The 2013 AARMS Mathematical Biology Workshop was held on July 27-29, 2013 at Memorial University of Newfoundland (MUN) in St John's. The workshop consists of 30 contributed talks, 6 plenary lectures and a public lecture. Highlights of the workshop were plenary talks by Drs. Linda Allen, Edward Allen, Steve Cantrell, Odo Diekmann, Mark Lewis, and Philip Maini, a public lecture by Dr. Simon Levin, and a banquet held at the SUNCOR Energy Fluvarium. A summary of the workshop (and the concurrent AARMS Mathematical Biology Summer School) by Kelsey Gasior, a graduate student from North Carolina State University, was published in the Society for Mathematical Biology Digest (September 2013, vol 26, No 3) and the AARMS Newsletter (Autumn 2013). Ms. Gaisor described being part of the AARMS Mathematical Biology Summer School and Workshop as 'a once in a lifetime opportunity'. The workshop was attended by 84 participants: 2 undergraduates (2%); 51 graduate students (61%); 6 postdocs (7%) and 25 faculty members (30%). 25 participants were from Atlantic Canada (30%), 16were from other parts of Canada (19%), 27 from the United States (32%), 10 from the European Union (12%) and 6 participants were from Asia (7%).
Also funded by CRM

**CCCG 2013 and Summer School**
Organizers: Alex Lopez-Ortiz, Anna Lubiw, Therese Biedl
Location: University of Waterloo
Date: August 4-11, 2013

The 25th Canadian Conference on Computational Geometry (CCCG) and the Summer School in Geometry and Data were held August 5-7 at the University of Waterloo. The summer school consisted of two three-day research courses taught by

Dr. J. Ian Munro and R. Timothy Chan. The day's events consisted of two 90 minute sessions separated by a 30 minute break in the morning and homework sessions in the afternoon. The exercises given consisted of advance research problems and were marked by a teaching assistant. There were 40 students attending the Summer School, 30 of which received travel funding. This was followed by the CCCG with 93 participants of whom 45 were graduate students. There were two invited lectures given by Dr. All Sheffer (UBC) and Dr. Sue Whitesides (Victoria) on recent developments in Computational Geometry. Overall the attendees were approximately one third from Canada, one third from the USA and the rest from Europe, East Asia, Israel, Australia, Brazil, Finland, Iran, India, Netherlands, Italy and Australia. There were two volumes resulting from these events. First the conference proceedings for CCCG 2013 which are available electronically and listed in DBLP and second a volume in the Springer LNCS series (vol. 8066) containing 22 research articles spanning 363 pages. Additionally there is a forthcoming special issue on selected papers from CCCG 203 to appear in the journal *Computational Geometry: Theory and Applications*. Several collaborations were initiated during the sessions. As well there was an open problem session during CCCG, with results from that research to be presented in CCCG 2014.
Also funded by Fields

**Science Atlantic Mathematics, Statistics and Computer Science Conference**
Organizers: Shannon Fitzpatrick, Gordon MacDonald, Chris Vessey, Nasser Saad, Cezar Campeanu
Location: University of Prince Edward Island
Date: October 18-20, 2013

The Science Atlantic Mathematics, Statistics and Computer Science Conference was held at UPEI on the third weekend of October 2013. The conference began on Friday at noon with student competitions in both Mathematics and Computer Science. A Pizza Party for competition participants followed this. On Friday evening, the Blunden Lecture was given by Dr. Anthony Bonato, Ryerson University who spoke on “Six Dimensions of Separation in Social Networks”. Saturday’s program consisted of two plenary talks, undergraduate talks in mathematics and computer sciences, as well as contributed talks. A total of 18 undergraduate mathematics talks were given. The undergraduate student talks were judged, and prizes were given to the top three talks, with the top prize going to Matthew van Bommel of Acadia University. In computer science, there were six undergraduate talks, with the award for best talk going to William Herring of the University of Prince Edward Island. In the contributed talks sessions, there were eight mathematics talks, and three computer science talks, all given by graduate students. As for plenary talks, the Sedgwick Lecture was given by Dr Lila Kari who spoke on “Are you smarter than a cucumber?; How to measure and

visualize species' relatedness", and the Field Lecture was given by Dr Mark Glickman who spoke on "Rating the Chess Rating System". Saturday's activities concluded with a conference banquet, where winners for best talks, as well as competition winners were honoured. On Sunday, a special AARMS session in Graph Theory was held. The AARMS Graphs and Games collaborative research group hosted this session. The conference was a very successful event. The plenary lectures were exceptional, and the students benefitted from the fact that even though the lectures were categorized as mathematics, computer science and statistics, respectively, they were all very multi-disciplinary. There was also a common theme in that analysis of large data sets was important in all three researchers' work. The talks gave students a great insight into the current state of researchin these areas. The total attendance for the conference was 181. There were 119 undergraduate students, and 62 other participants (faculty, graduate students, etc.) All participants were from the Atlantic Provinces.

Also funded by Science Atlantic

**Sustainability of Aquatic Systems Networks**

Organizers: Frithjof Lutscher, James Watmough
Location: University of New Brunswick, Fredericton
Date: October 22-25, 2013

The AARMS-CRM workshop on *Sustainability of Aquatic Ecosystem Networks* was held at the Fredericton Inn in Fredericton, New Brunswick, Canada, October 22-25, 2013. This workshop was the 10th in a series of 11 workshops in the pan-Canadian MPE thematic program on Models and Methods in Epidemiology, Ecology and Public Health. The main objective of the workshop was to provide a forum for the exchange of empirical results and modelling frameworks for spatially distributed aquatic systems, with a particular focus on issues of management and sustainability. These problems are of particular interest to Canada with its thousands of lakes, many major rivers, countless streams and three bordering oceans. Understanding the connections between these waters and their ecosystems is essential to understanding the impacts of human activities. Stresses on lake populations include events upstream; introduced species spread through networks of lakes and rivers; colonizers from marine protected areas may rescue impacted ecosystems, but the stress from these impacts may also spread to protected areas. The AARMS workshop aimed to foster a cross-disciplinary exchange of ideas and techniques between mathematicians, ecologists and resource managers, leading to new opportunities for mathematicians, and new tools for managers.

The first two days of the workshop focused on mathematics of river networks, while the second two days focused on spatially explicit marine systems. In both cases, equal emphasis was placed on both detailed, data-rich models and simpler strategic models, with the simpler models providing a baseline for studies of detailed spatially explicit simulations of rivers and streams. Continuing advances in the power and availability of high performance computing lead to steadily richer hydrodynamic models for rivers and coasts, and modellers are now moving to integrate physiological and behavioural models for fish and other organisms into these detailed hydrodynamic models. At the same time, these large tactical models are balanced by studies of simpler dynamical systems on connected patches and graphs representing river networks and coastal habitats. Although there were many similarities in the mathematics for riverine and coastal systems, there were also interesting differences. As expected, spatial models of river systems were based on branching networks, and a reoccurring question was the effect of barriers on species persistence. In contrast, metapopulation models made an appearance in modelling marine systems. Even in coastal systems, where the domain might be reasonably represented by a one dimensional chain of habitats, marine organisms are free to disperse in two or three dimensions and can move from one habitat to another without passing through the intervening patches. The same is not true of river networks, where most organisms are constrained to move along the network. The talks and discussion covered a wide variety of topics. Open data, invasive species, persistence, hydropower, range shifts, sustainable and optimal fisheries, and restoration to name a few.
Also funded by CRM, NSF and SMB

**Events Funded solely by AARMS and host universities:**

**Atlantic General Relativity Meeting**
Organizers: Viqar Husain, Sanjeev Seahra
Location: University of New Brunswick, Fredericton
Date: April 25-26, 2013

The 2013 Atlantic General Relativity meeting was held at UNB (Fredericton) on April 25 and 26th, 2013. The invited speaker was Prof. Steven Carlip from the University of California (Davis), a well known researcher in quantum gravity. All together there were 28 participants, and all the major groups working in this area in the Atlantic region participated, including several graduate students and postdocs. As such it was one of the larger meetings of its type. Prof. Carlip delivered 2 plenary hour talks (one of

which was a joint colloquium with the Physics and mathematics departments, as well a presentation at the conference.) The talks were on conformal descriptions of black hole entropy and spontaneous dimensional reduction in quantum gravity, both of which are areas of significant international research. There were 14 additional half hour talks given by students, postdocs and faculty from Dalhousie, Memorial, St. Francis Xavier, and UNB. The talks ranged across wide spectrum of research in classical and quantum gravity. Overall it was considered a very successful meeting.

**East Coast Combinatorics Conference 2013**
Organizer: Robert Gallant
Location: Grenfell Campus, Memorial University, Corner Brook
Date: May 8-10, 2013

The ninth annual East Coast Combinatorics Conference was held at the Grenfell Campus of Memorial University during May 9-10, 2013. This conference is designed to attract regional mathematicians, computer scientists, and graduate students interested in various aspects of discrete mathematics. The intended scope of the conference includes graph theory, extremal combinatorics, combinatorial optimization, probabilistic combinatorics, combinatorial number theory, design theory, nite geometries, and applications of combinatorics in computer science. The conference was made possible through funding from AARMS, and funding from the St. Johns and Grenfell campuses of Memorial university. The conference attracted 16 registered participants, of which 13 were regional and 3 were national/international. This year we were delighted to attract plenary lectures from internationally recognized experts. Professor Charles Colbourn, a researcher with over 400 publications in discrete mathematics and computer science, spoke on \F-Vectors of Pure Complexes and Pure Multicomplexes of Rank Three", which outlined his recent work to solve some open questions arising from questions in commutative algebra. Professor Kieka Mynhardt, an expert in the area of graph domination, gave a survey talk on the topic of “Broadcast Domination in Graphs", which in particular discussed recent connections to the multipacking number in graphs. In addition to exposing regional researchers to world-class plenary speakers, a major benefit of the conference is to help maintain and strengthen collaboration of researchers in discrete mathematics in Atlantic Canada. To this end the conference included a problem workshop, which was well attended.

**Foundational Methods in Computer Science 2013**
Organizers: Geoffrey Cruttwell, Robert Rosebrugh
Location: Mount Allison University, Sackville
Date: May 31 - June 2, 2013

Foundational Methods in Computer Science (FMCS) 2013 was held at Mt. Allison University from May 31st to June 3rd, 2013. There were 26 participants of whom 11 were from the Atlantic region, 10 from elsewhere in Canada, and 5 from other countries (America, Spain, and Italy). Scientific activities consisted of four tutorials by international speakers and 14 contributed talks. Activities included a welcome reception and excursion to Joggins. One invited speaker, Michael Shulman, spent this academic year at the Institute for Advanced Study during Field's medalist Voevodsky's thematic year on homotopy type theory and, in a two hour tutorial, described many of the new advances that came as a result of the work there. From Spain, Joachim Kock gave a tutorial on exciting new work on polynomial functors. From the United States, Ernie Manes gave a tutorial on how atoms in extensive categories can help us understand combinatorial problems. Finally, from Italy, the founder of the use of monads in computer science, Eugenio Moggi, spoke on interactions between computer science and type theory. A tradition at FMCS meetings is encouragement of graduate students. There were 7 lectures by students from Calgary, Ottawa, Dalhousie and York at the meeting, on such diverse topics as categorical vector-valued integration, partial term rewriting, and orbifolds as groupoids. The scientific level was very high in all cases.

**International Workshop in Combinatorial Algebra**
Organizers: Yuri Bahturin, Margaret Beattie, Sara Faridi, Mihail Kotchetov, Mitja Mastnak Hamid Usefi
Location: Dalhousie / St. Marys, Halifax
Date: June 1-6, 2013

The aim of this Workshop was to discuss the current state of research in several interrelating areas of modern Combinatorial Algebra, with emphasis on the Combinatorics of Commutative Algebras, Groups and Hopf Algebras. The workshop was a satellite event to two special sessions of the Summer 2013 Meeting of Canadian Mathematical Society, which ran on June 4 – 7. These sessions were “Commutative Algebra and Combinatorics” organised by Jennifer Biermann (Lakehead), Sara Faridi (Dalhousie), Andrew Hoefel (Queen’s) and Adam Van Tuyl (Lakehead); “Hopf Algebras and Tensor Categories” organised by Yuri Bahturin (MUN), Margaret Beattie (Mount Allison), Mitja Mastnak (Saint Mary’s) and Bob Pare (Dalhousie). The Workshop was organised by Atlantic Algebra Centre (Director Yuri Bahturin), affiliated to Memorial University of Newfoundland and supported as Collaborative Research Group by the Atlantic Association for Research in the Mathematical Sciences. The program of the workshop included a total of of 23 lectures and longer research talks, as well as a number of shorter research communications. Invited lecturers were Marcello Aguiar (Texas A&M University), Yuri

Bahturin (Memorial University), Matej Bresar (University of Ljubljana & Maribor, Slovenia), Vesselin Drensky (Academician of Bulgarian Academy of Sciences) and Jürgen Herzog (University of Duisburg-Essen, Germany). As part of the workshop, an AAC Mini Course entiteled “Commutative Algebra” was organized by Sara Faridi. The speakers were Jürgen Herzog and Giulio Caviglia, with June 4th being entirely dedicated to the Mini Course. A number of contributed talks have been given by other mathematicians, including undergraduate and graduate students as well as postdoctoral fellows affiliated to Atlantic Algebra Centre. The total number of participants was 46: 16 from Atlantic Canada, 11 from other provinces of Canada, 19 from other countries. One session on June 2 was dedicated to the work of Professor Tony Geramita from Queens University and one on June 3 to Professor Luzius Grunenfelder, a retired Dalhousie Professor (now at UBC).
An Atlantic Algebra Centre event

**Analytic Spaces and Their Operators**
Organizers: Jie Xiao, Kehe Zhu
Location: Memorial University, St. John's
Date: July 9-12, 2013

The 2013 workshop on Analytic Spaces and Their Operators took place at Memorial University in St. John's July 9 – 12, 2013. Altogether, 31 participants enrolled in this event. Among them were 7 participants from China and USA; 13 participants from Quebec; and 21 participants from Newfoundland. Invited speakers included Paul Gauthier (Montreal), Gang He (Zunyi Normal, China), Zhongkai Li (Capital Normal, China), Wenxue Xu (Southwest U., China), Jiazhu Zhou (Southwest U., China) and Baocheng Zhu (Southwest U., China).

**Games and Graphs AARMS Session of the Science Atlantic Mathematics & Statistics Conference**
Organizers: Stephen Finbow, Shannon Fitzpatrick
Location: University of Prince Edward Island
Date: October 18-20, 2013

The AARMS Session of the Science Atlantic Combinatorial Conference in 2013 was the first event hosted by the newly formed Games and Graphs AARMS collaborative research group. The goal of the research group is to promote research in graph theory and combinatorial game theory at all levels and a core interest is the interaction of graphs and disciplines outside of graph theory, and the structures that arise. A major emphasis is on interactions that have a dynamical aspect. The purpose of this session was to: support and bring together researchers in discrete

mathematics in Atlantic Canada encouraging the sharing of ideas and problems; highlight the major theoretical advances and applications in the area along with the development of new tools; encourage active participation for undergraduate and graduate students providing exposure to new talent; and provide an opportunity to begin new collaborations. The session featured contributed graduate student presentation, two keynote speakers, Dr. Ortrud Oellermann of the University of Winnepeg (Reconstructing a Graph from its Digitally Convex Set) and Dr. Andrew Beveridge of Macalester College (Maker-Breaker Games on Random Geometric Graphs), a discussion on open problems in the field as well as time dedicated for researchers to break into smaller groups. This year's session was by all reports a success. The session had thirty-six participants, including fourteen faculty from the Atlantic region, the two keynote speakers and the Blundon Lecturer, Dr. Anthony Bonato, who presented related research on Friday. Problems of various levels were presented and the open problem session had to be extended to allow time for discussions to be completed. Several new collaborations were formed.

A Graphs and Games CRG event

## *Outreach*

In 2013 AARMS supported the following outreach programs:

**Enhancing Our Appreciation of Mathematics Through Intentional Community Outreach**

A program for developing public appreciation of mathematics: by creating a recreational mathematics exhibit, displayed in libraries; by implementing a public lecture series in the Fredericton Library; and by interactive visits to schools. Organized by John Grant McLoughlin (staffed by volunteers from the UNB Faculty of Education, UNB).

Sisters Madison and Samara enjoying math games in Fredericton

Dr. McLoughlin is also the recipient of the **2013 Adrien Pouliot Award** from the Canadian Mathematical Society in recognition of his outstanding contributions to mathematics education in Canada.

"What is significant about John is his deep humanity and his mentorship of both students and teachers, those with strong ability in the subject as well as those who approach mathematics with caution and nervousness," said Keith Taylor, President of the Canadian Mathematical Society. "As a professional he is an effective bridge between the worlds of Mathematics and Math Education."

**UNB-CMS Mathematics Camp, Grades 10-11** – A long weekend of mathematical activities for grade 10 and 11pupils presented by the faculty, students and staff of the UNB Dept of Mathematics and Statistics in Fredericton. Organized by Daryl Tingley

**The New Brunswick Mathematics Competition, Grades 7-9** – Carried out at the University of New Brunswick in Fredericton and Saint John and l'Université de Moncton in Moncton, Edmunston and Shippagan, this goal of this one-day event is to encourage students with an interest and ability in mathematics and to introduce them to university mathematics. The competition paper was available in French and English at all locations. A total of 1243 students participated, representing 161 schools from all seven school districts. District winners for each grade received diplomas and either a book (English districts) or a magazine subscription (French districts). Pewter medals were awarded to the top three students in the province in each grade. Thetop three students in eachh grade, at each campus, also received cash prizes donated by sponsors.
Also sponsored by the Province of New Brunswick, Morneau Shepell, CIBC Wood Gundy, IA Clarington and the CMS

**The Blundon Math Camp and Seminar** – The W.J. Blundon Seminar is an annual three-day event organised by the Department of Mathematics and Statistics at Memorial University of Newfoundland, and held at its St. John's campus. Senior high school students from across Newfoundland and Labrador are invited to the Seminar based on their performance in the Euclid, Fermat and Cayley contests run by the University of Waterloo, as well as the Blundon contest administered by Memorial University. The Seminar runs for three days and two nights, during which students room together in a University residence. The goals of the Seminar are to expose Newfoundland and Labrador's best high school students to university-level mathematics and mathematical research; to help them hone their mathematical problem-solving skills; and to familiarise them with the University, with the Department, and with their peers. In addition to interacting with faculty from the Department, the students are also proctored by two senior undergraduate mathematics students (one male and one female), giving them the opportunity to gain insight into the university experience from individuals of a comparable age. The centrepiece of the 2013 Seminar was a set of team-oriented problem solving sessions, in which the students were mentored by Memorial faculty. Many of the problems assigned to the students were designed to be more challenging than those typically encountered in high school, and sought to focus on advanced techniques and approaches useful in post-secondary mathematics contests. These sessions were supplemented by a less traditional problem solving competition called the "Paper Chase", in which the students formed teams to participate in a mathematical scavenger hunt around the Department's facilities. The Paper Chase generally featured less rigorous questions than the standard problem solving sessions, and was instead designed to be a fast-paced and entertaining component of the Seminar schedule. The students also attended two seminars in which the speaker was asked to deliver a presentation about university-level mathematics using language accessible to the high school audience. Dr. Thomas Humphries, a post-doctoral fellow

in the Department, gave a talk about simulation and optimisation, concentrating on the application of mathematics to oil exploration in the Newfoundland offshore. Dr. Taraneh Abarin, an assistant professor in the Department, spoke about the modern frontiers of statistics, tying into the just-completed redevelopment of the Department's Statistics programs and courses. Finally, the students were invited to a formal banquet at which awards were presented for the best results in the Blundon, Euclid, Fermat and Cayley contests (with the top students in the Pascal contest also recognised for their achievements in absentia).
Also sponsored by the Province of Newfoundland, Newfoundland Power, CAIMS and the CMS

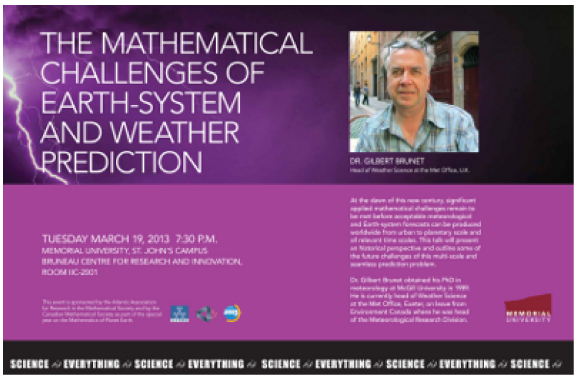
**Nova Scotia Math Circles** - NS Math Circles is an outreach program that is based out of Dalhousie University that is dedicated to enriching the experiences of Nova Scotia high school students in all areas of mathematics. The program provides engaging, fun mathematical presentations, which are given in high school classes, free of charge. Some presentations are related to curriculum outcomes, others go beyond to offer enrichment. Every year the NS Math circles team visits different school boards across the province. For each school board visit, 2-4 graduate students rent a vehicle and spend one week visiting schools within that board. Such a trip can provide outreach to over 300 students. From Fall 2009-Summer 2013, Math Circles has provided outreach to senior high schools. During this time there were requests for presentations from junior high schools, but Math Circles was unable to meet this need, as the focus was on the senior high classes (grades 10-12). Since students need to pick their mathematical stream in grade 10, this turned the attention of the Math Circles organizers to focusing on the junior high grades, with the hopes that students will see that mathematics can be fun, interesting and useful and that this may positively influence their streaming choice in grade 10. In early 2013 Math Circles gave a pilot problem-solving workshop to 14 classes (over 400 students) ranging from grades 7-9 in the Halifax Regional School Board and Strait Regional School Board. The workshop has been well received by both teachers and students. In the summer they began focusing on the new junior high initiative, which consisted of creating presentations for grades 7-9 over the 2013-14 academic year, as well as continuing the work with senior high school students at the same time.
Also sponsored by Imperial Oil

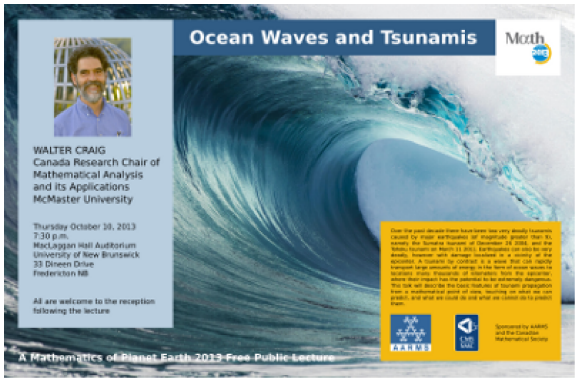
## *Mathematics of Planet Earth*

The International Mathematics community designated 2013 as the year of the Mathematics of Planet Earth. All around the world mathematical events focused on this theme. At AARMS we embraced the theme through the following activities:

**In association with the Canadian Mathematical Society AARMS presented the following public lectures:**

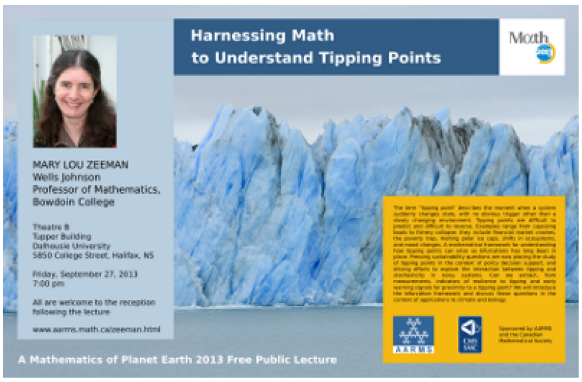
**The Mathematical Challenges of Earth-System and Weather Prediction**
Speaker: Gilbert Brunet
Organizer: Edgar Goodaire
Location: Memorial University, St. John's
Date: March 19, 2013




**Ocean Waves, Rogue Waves, and Tsunamis**
Speaker: Walter Craig
Organizer: David Bremner
Location: University of New Brunswick, Fredericton
Date: October 10, 2013

**Harnessing Math to Understand Tipping Points**
Speaker: Mary Lou Zeeman
Organizers: Jeannette Janssen, David Iron
Location: Dalhousie University, Halifax
Date: September 27, 2013




**The AARMS Summer School**

The 2013 AARMS Summer School presented four courses on the MPE theme - two in Mathematical Biology and two in Dynamical Systems. There was also an associated workshop in Mathematical Biology (see below).

**Workshops** (see more detailed descriptions under “Conferences and Workshops”

**2013 Workshop in Mathematical Biology**. Organizers: Amy Hurford and Xiaoqiang Zhao. St. John's, July 27-29, 2013.

**Sustainability of Aquatic Ecosystems Networks**. Organizers: Frithjof Lutscher and James Watmough. Fredericton, April 22-26, 2013. This is part of pan-Canadian thematic program on Models and Methods in Ecology, Epidemiology and Public Health.

## *Administration and Governance*

**Jeannette Janssen, Director**
Department of Mathematics and Statistics
Dalhousie University

**Xiaoqiang Zhao, Deputy Director**
Department of Mathematics and Statistics
Memorial University of Newfoundland

**David Langstroth, Executive Administrator**
Dalhousie University

**The AARMS Executive Committee**

Jeannette Janssen (Dalhousie), Chair
Jacques Allard (Moncton)
David Bremner (New Brunswick)
David Irons (Dalhousie)
Paul Muir (St. Mary's)
Yuan Yuan (Memorial)
Xiaoqiang Zhao (Memorial)

**The AARMS Editorial Board**

Yuri Bahturin (Memorial), Chair
Robert Dawson (Saint Mary's)
Theodore Kolokolnikov (Dalhousie)
Lin Wang (New Brunswick)
David Langstroth, Managing Editor (AARMS Executive Administrator)

AARMS is established through a set of statutes signed by the largest university in each Atlantic Province: Dalhousie University, Memorial University, University of New Brunswick and University of Prince Edward Island. These statutes define an organizational structure which includes a Board, an Executive Committee and a Scientific Review Panel.

The Director and Executive Administrator of AARMS are based at Dalhousie University, and the Deputy Director is based at Memorial. The other members of the Executive Committee are drawn from Dalhousie, Memorial, Saint Mary's, the University of new Brunswick and Université de Moncton, a distributed membership which includes large universities and small ones and enables AARMS to be in touch with current issues through Atlantic Canada and to be in dialogue with researchers in all provinces.

The Board is comprised of major sponsors of AARMS including Directors of the three Institutes and senior administrators from the universities; it also includes representatives of industry members of the Executive Committee and other mathematical scientists. In 2013 we were pleased to welcome three new members to the Board: **David Bluteau** (National Bank), **Jason Powell** (PingIdentity), and the new Director of CRM, **Luc Vinet**.

Our Scientific Review Panel is composed of mathematical scientists from Canada and abroad who are nationally and internationally respected in their fields. This panel assesses applications to our postdoctoral fellowship program, our collaborative research group program, and evaluates the larger requests for funding for workshops and converences. It provides scientific advice when requested.

## The AARMS Board

**Jacques Yves Guigné, Chair** - serves as the Founder and President / Board Director of Intelligent Sciences Ltd. and Co-Founder, Director and Board member of PanGeo Subsea Inc. and of Acoustic Zoom Inc. (Jacques is the President and Chief Scientist/ Geophysicist for Acoustic Zoom Inc. and Executive Director and Chief Scientist/Geophysicist for PanGeo Subsea Inc.).

**Mark Abrahams** - a behavioural ecologist who studies the risk of predation and its impact upon aquatic ecosystems. This work is of fundamental importance to understanding how ecosystems operate, as well as having application to conservation ecology and invasion dynamics. He worked at the University of Manitoba for 18 years before moving to Memorial University where he is the Dean of Science.

**Alejandro Adem** - Canada Research Chair and Professor of Mathematics at UBC. He received his Ph.D. in 1986 from Princeton University and after a postdoctoral position at Stanford University he became a faculty member at the University of Wisconsin-Madison before moving to UBC in 2004. He has been Director of PIMS since July 2008. His research interests are primarily in algebraic topology and group cohomology.

**Jacques Allard** - Professor of Statistics at Université de Moncton. He received his Ph.D. from UBC and held post-doctoral positions at Oxford University and Université de Montréal. He has been professor at Université de Moncton since 1979 where he was also chair of the Département de mathématiques et de statistique from 2000 to 2006. Most of his research is in applied statistics with an emphasis on fisheries management application. He has also been a consultant to the private and public sectors since 1984.

awaiting image

**David Bluteau** - Branch Manager and Vice-President of National Bank Financial Wealth Management in Nova Scotia. He is responsible for the wealth management and estate planning for his physician clientele. He earned his Masters of Business Administration degree from Dalhousie University in 1987 and offers nearly 25 years as a financial advisor.

**David Bremner** - David Bremner holds Ph.D. in Computer Science from McGill University (1997). David was an NSERC postdoctoral fellow in the Department of Mathematics at the University of Washington from 1997 to 1999. Since 2000 David has been a faculty member at the University of New Brunswick, and is currently a Professor of Computer Science (cross-appointed to the Department of Mathematics and Statistics). David has held visiting positions at the Technical University of Munich (as an Alexander von Humboldt Fellow), the Hausdorff Research Institute for Mathematics. He is currently the MITACS Atlantic Scientific Director. David's main research interests are in geometric aspects of optimization, particularly algorithmic problems about convex polyhedra and hyperplane arrangements.

**David Burns** - Vice-President Research, UNB.

**Hugh Chipman** - Hugh Chipman is interested in computationally intensive statistical methods, including Bayesian computation, statistical and machine learning, and applications involving network data, drug discovery, and industrial statistics. He is a professor and Canada Research Chair at Acadia University's Department of Mathematics and Statistics. He received his doctorate at the University of Waterloo, and has held academic positions at the University of Chicago and the University of Waterloo.

**Walter Craig** - is a Professor of Mathematics and the Canada Research Chair (Tier I) of Mathematical Analysis and its Applications at McMaster University. His doctorate is from the Courant Institute (1981), and he has held faculty positions at Caltech, Stanford University and Brown University, where he was department chair, before moving with his wife to McMaster in the year 2000. He is a prominent mathematical analyst, whose interests include partial differential equations, Hamiltonian dynamical systems, and their applications to the physical sciences. His contributions have been to theoretical aspects of these fields, as well as their applications to fundamental problems in physics; these include small divisor problems in Hamiltonian partial differential equations, microlocal

propagation of singularities for the Schrodinger equation, advances in the mathematical theory of water waves and their modeling, and progress on the important issue of regularity for solutions of the Navier - Stokes equations. He has authored more than 100 research articles. He has organized several thematic programs at the Fields Institute, and has been a regular visiting member since his move to Canada. He served on the Fields Institute Scientific Advisory Panel (2000-2005), the Scientific Nominating Committee (2001-2005) and the Board of Directors (2009-2012). He has been awarded a Bantrell, a Sloan and a Killam Research Fellowships, and was elected as a Fellow of the Royal Society of Canada, of the AAAS and AMS, as well as a Fields Institute Fellow.

**Robert Gilmour** - currently is Vice President, Research at the University of Prince Edward Island. He formerly was a Professor of Physiology in the Department of Biomedical Sciences and Associate Dean for Research and Graduate Education at Cornell University, where he led a multidisciplinary group of investigators whose publications have appeared in both cardiovascular and physics journals. He also was a member of the Executive Committee for the IGERT-sponsored program in non-linear systems at Cornell and was a member of the Graduate Fields of Physiology, Pharmacology, Bioengineering and Computational Biology. His research interests are centered on theoretical and experimental studies of heart rhythm disorders. .

**Viqar Husain** - Professor in the Department of Mathematics and Statistics at the University of New Brunswick (Fredericton), and Affiliate Researcher at the Perimeter Institute since its founding. He received his PhD in theoretical physics from Yale University (1989). His fields of research are general relativity, cosmology, and quantum gravity. He has been Department Chair since 2007 and was Director of AARMS from 2008-2011.

**David Iron** - Assistant Professor at Dalhousie University. He received his PhD in Applied Mathematics at the University of British Columbia in 2001. His primary area of research is pattern formation in reaction-diffusion systems. Specifically, he studies the stability and dynamics of highly localized structures in these systems. In addition, he has collaborated with experimentalist in Chemistry and Biology.

**Jeannette Janssen - Director of AARMS**, Professor in the department of Mathematics & Statistics at Dalhousie University. She is a graph theorist, using techniques from probability and combinatorial optimization in her research. Her current interests focus on the modelling of complex networks, such as the networks of contacts formed through social media. She is one of the project leaders of the MITACS project: Modelling and Mining of Networked Information Spaces (MoMiNIS). Jeannette obtained her PhD in 1993 from Lehigh University in Pennsylvania, and her first graduate degree (doctoraal diploma) in 1988 from the Technical University Eindhoven in the Netherlands.

**Paul Muir** - Professor, Department of Mathematics and Computing Science, Saint Mary's University. He received his Ph.D. from the University of Toronto in 1984 in Computer Science (Numerical Analysis). Dr. Muir's research is in the general area of numerical analysis; his specialties include the numerical solution of ordinary differential equations, with emphasis on boundary value ordinary differential equations and Runge-Kutta methods, and the adaptive method-of-lines solution of partial differential equations with collocation methods.

**John Newhook** - Associate Vice-President Research, Dalhousie University. He is a Professor in the Department of Civil and Resource Engineering and the Director of the Centre for Innovation in Infrastructure. He obtained a PhD in Civil Engineering from Dalhousie in 1997. His research interests are in the areas of structural health monitoring, bridge engineering and analysis, soil-structure interaction and modelling, and the use of advanced composite materials in infrastructure.

awaiting image

**Jason Powell** - Engineering Site Director for Ping Identity, a Denver-based software company that offers technology to protect professional and personal identities, and is responsible for launching and leading Ping Identityâ€™s new Halifax-based software engineering Centre of Excellence.

**Henrik Stryhn** - Professor in Biostatistics, Department of Health Management, Atlantic Veterinary College (AVC), University of PEI. He received his PhD from the Royal Veterinary and Agricultural University of Denmark (now part of the University of Copenhagen) in 1994. A statistician by training, he has been working extensively with applications of statistics in agriculture and veterinary science. Dr. Stryhn

emigrated from his native Denmark to Canada in 2001 to take up a position at AVC. His research interests include a broad range of methods in statistics and epidemiology, in particular models involving random effects and other latent variables.

**Luc Vinet** - is Aisenstadt Professor of Physics at the Université de Montréal and the Director of the Centre de Recherches Mathématiques (CRM). Born in Montreal in 1953, he holds a doctorate (3rd cycle) from the Université Pierre et Marie Curie (Paris) and a PhD from the Université de Montréal, both in theoretical physics. After two years as a research associate at MIT, he was appointed as assistant professor in the Physics Department at the Université de Montréal in the early 1980's and promoted to full professorship in 1992. His research interests in Theoretical and Mathematical Physics include : exactly solvable problems, symmetries, algebraic structures, special functions and quantum information. Luc Vinet has sat on the board of many organizations. He is currently a Director of the National Institute for Nanotechnology and chairs the Fulbright Canada Board of Directors. He was a member of the Council of Canadian Academies' Expert Panel which assessed the State of Science and Technology in Canada in 2012. He holds an honorary doctorate from the Université Claude-Bernard (Lyon). He was made an Officer of the Ordre des Palmes académiques by the French Government and Knight of the Ordre de la Pléiade by the Parliamentary Assembly of the Francophonie. In 2009, the Government of Quebec awarded him the Armand-Frappier Prize in recognition of his outstanding research career and of his contributions to the creation and development of research institutions. In 2012, he received the CAP/CRM prize in Theoretical and Mathematical Physics as well as the Queen Elizabeth II Diamond Jubilee Medal recognizing his contribution to the establishment of Mitacs.

**Yuan Yuan** - Professor at Memorial University of Newfoundland. She received her PhD in Applied Mathematics at the University of Western Ontario in 2002. Her research interests include Applied Dynamical Systems, Functional Differential Equations and Applications.

**Xiaoqiang Zhao** - Deputy Director of AARMS, University Research Professor at Memorial University of Newfoundland. He received his PhD in Applied Mathematics from Chinese Academy of Sciences in 1990. His research interests are Applied Dynamical Systems, Nonlinear Differential Equations, and Mathematical Biology.

## The AARMS Scientific Review Panel

**Xiaoqiang Zhao, Chair** - Deputy Director of AARMS and University Research Professor at Memorial University of Newfoundland. He received his PhD in Applied Mathematics from Chinese Academy of Sciences in 1990. His research interests are Applied Dynamical Systems, Nonlinear Differential Equations, and Mathematical Biology.

**Yuri Bahturin** - University Research Professor at the Department of Mathematics and Statistics, Memorial University of Newfoundland, Coordinator of the Atlantic Algebra Centre, and Chair of Higher Algebra at the faculty of Mechanics and Mathematics, Moscow State University. His main occupation is research, supervising and teaching in algebra. He has published more than 100 books and papers, supervised 15 PhDs and more than 20 MSc students.

**Michael Bennett** - is professor and head of the Department of Mathematics at the University of British Columbia, where he has been a faculty member since 2001, and from where he obtained his PhD in 1993. Previously, he held positions at the University of Waterloo, the University of Michigan, The Institute for Advanced Study, Princeton, and at the University of Illinois, Urbana-Champaign. He has served on the Board of Directors of the Canadian Mathematical Society as Vice President (West) and currently serves on the board of the Number Theory Foundation. His main research interests are in Number Theory, where he has published extensively.

**Chen Greif** - is a professor of computer science at the University of British Columbia, where he holds a faculty position since 2002. He received B.Sc. and M.Sc. degrees in applied mathematics from Tel Aviv University, and obtained his PhD (applied mathematics) from UBC in 1998. Before joining UBC as a faculty member he was a postdoctoral fellow at Stanford University (1998-2000) and a Senior Software Engineer at Parametic Technology Corporation (2000-2002). He is an Associate Editor with the SIAM Journal on Scientific Computing, and the Program Director of the SIAM Activity Group on Linear Algebra. His main area of interest is scientific computing, and in particular numerical linear algebra.

**Javad Mashreghi** - is a Professor of Mathematics at Laval University. He obtained his bachelor degree in electrical engineering from the University of Tehran, and his Ph.D. in pure mathematics from McGill University in 2001. He has served in the board of directors of the Canadian Mathematical Society (CMS) and Centre de Recherches Mathématiques (CRM), and faculty Council of the Faculty of Science and Engineering of Laval University. He has published 4 books and his main interests are complex analysis and operator theory.

**James A. Mingo** - James A. Mingo was a student at Dalhousie University where he completed his PhD under the supervision of Peter Fillmore in 1982. He was a visiting assistant professor at Purdue University and UCLA, and a NSERC University Research Fellow at the University of Toronto. Since 1987 he has been at Queen's University and a professor there since 1997. He has served on various committees of the Canadian Mathematical Society including a term as Vice-President (Ontario) and Chair of the Finance Committee. His research interests concern operator algebras, free probability and random matrices. In particular the application of combinatorics to the study of the eigenvalue distribution of large random matrices.

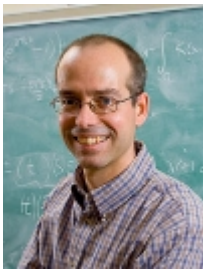
**Matthias Neufang** - is a graduate of France's Université de Lille 1. He received a Mathematics PhD in 2000 from the UniversitÃ¤t des Saarlandes for his thesis entitled "Abstract Harmonic Analysis and Module Homomorphisms on von Neumann Algebras". He has taught at the University of Alberta and Carleton University. His principal work involves functional analysis and harmonic analysis, investigating the links between abstract harmonic analysis and Banach and operator algebra theory. He is the author of over fifty research papers and has

organized numerous research conferences and special sessions. Neufang served as Interim Deputy Director of the Fields Institute from January to June 2009. He also served as Director of the Ottawa-Carleton Institute of Mathematics and Statistics, and Associate Dean of the Faculty of Graduate Studies and Research at Carleton University. His service to the profession include the positions of member of the Board of Directors of the Canadian Mathematical Society, as well as chair of the Natural Sciences and Engineering Research Council Pure Mathematics Grant Selection Committee.

**Michael A. Newton** - Professor at the University of Wisconsin Madison, in the Departments of Statistics and of Biostatistics and Medical Informatics, where he has worked since completing his PhD in Statistics at the University of Washington in 1991. He earned his undergraduate degree in Mathematics and Statistics from Dalhousie University in 1986. Dr. Newton's research concerns the use of statistics in the biological sciences, especially inference problems in genomics and cancer biology. His service includes a term on the genome study section of the US National Institutes of Health, and a term as biological sciences editor of the Annals of Applied Statistics.

**Mary Pugh** - received a BA in pure mathematics from U.c. Berkeley in 1986, and MS and PhD degrees in mathematics from the University of chicago in 1988 and 1993, respectively. From 1993 to 1997, she was a post-doc at the Courant Institute and at the Institute for Advanced Study. From 1997 to 2001, she was an assistant professor at The University of Pennsylvania. Since 2001, she has been an associate professor at the University of Toronto. Her research is largely on the modeling, analysis, and simulation of thin films of viscous liquids, with a broader interest in computational methods for partial differential equations.

**Hugh Thomas** - University of New Brunswick. Associate Professor in the Department of Mathematics and Statistics at the University of New Brunswick. He received his Ph.D. in Mathematics from the University of Chicago in 2000. His research interests are in algebraic combinatorics, representation theory, and algebraic geometry. He presently serves on the board of the Canadian Mathematical Society.



**James Watmough** - received his Bachelor's degree in Engineering Physics in 1989 and his PhD in Applied Mathematics in 1997: both from the University of British Columbia. He held a postdoctoral position at Virgina Tech and a NSERC postdoctoral fellowship at the University of Victoria. He is currently a Professor (Mathematics) at the University of New Brunswick, Fredericton. Dr. Watmough's research interests are in mathematical biology: specifically epidemiology and ecology.

**Juncheng Wei** - Chair Professor at the Department of Mathematics, Chinese University of Hong Kong. He received his PhD from University of Minnesota in 1994. After one year postdoc at SISSA, he moved to Chinese University of Hong Kong. He was the recipient of Croucher Senior Fellowship (2005) and Morningside Silver Medal (2010). He is included in ISIHighlyCited (2010). His main research interests are Nonlinear Partial Differential Equations, Concentration Phenomena and Blow Ups, and Mathematical Biology.

**Xingfu Zou** - Professor of applied mathematics at the University of Western Ontario. He received his Ph. D from York University in 1997. Before joining UWO in January 2004, he pursued postdoctoral studies at the University of Victoria (Jan. 1997-July 1998) and Georgia Institute of Technology (July-Dec 1998), and was a faculty at Memorial University of Newfoundland (Jan 1999-Dec. 2005). His research interests are in applied dynamical systems including theories of ODEs, PDEs and FDEs and applications to various problems arising from biology and other fields.

## *AARMS Financial Statements*

AARMS funds are held in accounts at Dalhousie University and The University of New Brunswick and are subject to the oversight and auditing of the Financial Services Departments of those universities. The following accounts are a view of the data compiled by Dalhousie and UNB.

The financial year is January 1 – December 31. The statements employ cash-flow accounting which is the method which records transactions when funds move, rather than when transactions are accrued. This is consistent with university statements but may create timing anomalies: if an event in 2012 is paid for in 2013 then it will show up in the 2013 accounts.

# Income and Expenditure Account
## 2013

| ***Income***[1] | $ | $ | 2012 |
|---|---|---|---|
| Carried forward from previous year | | 100,970 | 80,268 |
| Mathematical Institutes | | 75,000 | 90,000 |
| Universities | | 82,000 | 97,000 |
| Provinces | | 100,000 | 50,000 |
| Other Revenue (1) | | 141 | 0 |
| **Total Income** | | **358,111** | **317,268** |
| ***Expenditure*** | | | |
| Summer School | | | |
| Instructors (2) | 40,664 | | 23,388.41 |
| Students (3) | 26,060 | | 0.00 |
| Other (4) | 3,357 | | 100.00 |
| | 70,081 | **70,081** | 23,488 |
| Workshops and Events (5) | | 35,853 | 37,399 |
| Outreach (5) | | 7,179 | n/a |
| PDF Program (6) | | 101,780 | 100,000 |
| Collaborative Research Groups (7) | | 36,000 | 24,000 |
| Distinguished Lecturer Series | | 7,246 | 0 |
| Book Series | | 0 | 0 |
| Administrator Salary | | 29,250 | 28,823 |
| AARMS Online system | | 5,395 | 1,385 |
| Travel | | 2,302 | 0 |
| Office Expenses | | 1,249 | 1,204 |
| Other | | 0 | 0 |
| **Total Expenditure** | | **296,336** | **216,299** |
| **Surplus: Income Less Expenditure** | | **61,775** | **100,970** |

Notes

1. For a breakdown see Appendix 1
2. Travel, Accommodation and stipends of $5,000 each
3. Residence and Meals
4. Texts and course materials, promotion, secretarial, computing , hospitality
5. See Appendix 2
6. See Appendix 3
7. See Appendix 4

# Balance Sheet

31-12-2013

| ***Assets*** | $ | $ |
|---|---|---|
| Surplus from Operations (Income less expenditure) | | 61,775 |
| Accounts Receivable[1] | | |
| CRM | 45,000 | |
| Fields | 30,000 | |
| PIMS | 45,000 | |
| Acadia | 5,000 | |
| Cape Breton | 2,000 | |
| Dalhousie | 35,000 | |
| Memorial | 30,000 | |
| Moncton | 1,000 | |
| Mount Allison | 1,000 | |
| Saint Francis Xavier | 1,000 | |
| Saint Mary's | 1,000 | |
| UNB | 45,000 | |
| UPEI | 1,000 | |
| Province of Nova Scotia | 50,000 | |
| Province of New Brunswick | 0 | |
| | | 292,000 |
| **Total Assets** | | **353,775** |

| ***Liabilities*** | | |
|---|---|---|
| Accounts Payable[2] | | |
| Summer School | 122,000 | |
| Postdoctoral Fellowships | 66,971 | |
| Scientific Activities[3] | 66,126 | |
| Outreach | 2,000 | |
| Collaborative Research Groups | 48,000 | |
| AARMS Book Series | 1,000 | |
| Administrator Salary[4] | 28,761 | |
| online development | 1,000 | |
| AARMS Poster | 700 | |
| Travel and Office expenses | 3,000 | |
| | | 339,558 |
| Unallocated funds - for AARMS activities | | 14,217 |
| **Total Liabilities** | | **353,775** |

Notes

1. Fees due to be collected in 2014
2. Funding Commitments in 2014
3. Workshops, Conferences, Meetings, Atlantic Algebra Centre

# Annual Accounts 2013

## Appendix 1

### *Revenue Breakdown*

| | | | |
|---|---|---|---|
| Provinces | | | |
| | New Brunswick | 50,000 | |
| | Nova Scotia | 50000 | |
| | | | **100,000** |
| Mathematical Institutes | | | |
| | CRM | 30,000 | |
| | Fields | 30,000 | |
| | PIMS | 15,000 | |
| | | | **75,000** |
| Universities | | | |
| | Acadia | 5,000 | |
| | Cape Breton | 0 | |
| | Dalhousie | 12,000 | |
| | Memorial | 30,000 | |
| | Moncton | 1,000 | |
| | Mount Allison | 1,000 | |
| | Saint Francis Xavier | 1,000 | |
| | Saint Mary's | 1,000 | |
| | UNB | 30,000 | |
| | UPEI | 1,000 | |
| | | | **82,000** |
| Other Revenue | | | |
| | book royalties | 118 | |
| | return of unspent pdf funds | 23 | |
| | | | **141.11** |
| | **total** | | **257,141** |


# Annual Accounts 2013

## Appendix 2

### *Workshops and Scientific Events*

| | |
|---|---|
| Science Atlantic 2012 | 1,001 |
| Combinatorial Theory of Groups & Hopf Algebras | 2,500 |
| 14th Cdn Conf. on Gen. Relativity and Relativistic Astrophysics | 796 |
| Atlantic General Relativity Conference | 2,288 |
| International Statistics Symposium 2012 | 6,000 |
| Noncommutative Geometry | 2,000 |
| SAGE Days at Acadia | 3,384 |
| Groups, Rings, Lie and Hopf Algebras III | 4,725 |
| 2013 East Coast Combinatorics Conference | 2,000 |
| CMS poster session prize | 1,000 |
| Statistical Society of Canada annual meeting | 2,000 |
| International workshop in Combinatorial Algebra | 1,484 |
| Atlantic General Relativity Conference | 2,800 |
| Analytic Spaces and their Operators | 2,000 |
| International Workshop in Combinatorial Algebra | 1,874 |
| **total** | **35,853** |

### *Outreach*

| | |
|---|---|
| UNB Math Camp | 346 |
| NB Math Competition | 333 |
| John McLoughlin – NB Outreach program | 3,000 |
| Math Circles | 3,500 |
| | **7,179** |


# Annual Accounts 2013

## Appendix 3

### *Postdoctoral Fellowships*

| | |
|---|---|
| Rui Peng | 8,750 |
| Alexei Gordienko | 8,750 |
| Ryan Tifenbach | 29,279 |
| Hongying Shu | 8,750 |
| Charles Paquette | 11,250 |
| Francis Valiquette | 17,500 |
| Rogers Mathew | 8,751 |
| Yuzhao Wang | 8,750 |
| **total** | **101,780** |

## Appendix 4

### *Collaborative Research Groups*

| | |
|---|---|
| Atlantic Algebra Centre | 12,000 |
| Mathematical Ecology and Epidemiology | 12,000 |
| Statistical Modelling of Complexly Correlated Data with Applications | 12,000 |
| **total** | **36,000** |