Newsletter *Autumn 2014*

AARMS-PIMS Summer School 2015

The Summer School in 2015 will be held at Dalhousie University July 6 – August 31. As usual, four courses will be offered:

Waves and patterns in nonlinear systems Instructors: Andrea Bertozzi and Ricardo Carrettero
Topics in Reaction-Diffusion Systems: Theory and Applications Instructors: Michael Ward and Juncheng Wei
Structure-Preserving Discretization of Differential Equations Instructors: Elena Celledoni and Brynjulf Owren
Numerical Analysis of Singularly Perturbed ODEs and PDES Instructor: Martin Stynes

Our goals are to broaden the education of graduate students and to encourage promising undergraduates to continue their study. While, in a given year, a good number of students come from Canada, our School continues to bring to Atlantic Canada students from around the world. Indeed, the multicultural, international flavour of our School and the possibility of forming lifelong friendships and collaborations amongst people of different backgrounds and cultures is one of our School's strengths.

Each course consists of 5 ninety minute lectures per week. Grades are assigned and certificates of completion are issued to successful students. Since our courses are Dalhousie University graduate courses, we hope that students' home institutions will offer transfer credit for AARMS summer courses. Certainly, we are prepared to help students achieve local credit in any way possible.

This year there will also be three workshops associated with the Summer School:

Bluenose Applied and Computational Math Days - July 11-12; **Workshop on Pattern Formation in Differential Equations -** July 18-19; **Workshop on Domain Decomposition Methods for PDEs**: Aug 4-8

We are grateful to PIMS for their generous sponsorship of this year's summer school. For more information or to apply please visit the website: www.aarms.math.ca/summer

Bluenose Applied and Computational Math Days

The 2015 Bluenose Applied and Computational Math Days Workshop will be held at Saint Mary's University, July 11-12. This workshop is being held in association with the 2015 International Federation for Information Processing (IFIP) Working Group 2.5 on Numerical Software business meeting (which will be held at Saint Mary's July 9-10, 2015) and will take place on the first weekend of the 2015 AARMS Summer School. This Bluenose workshop is the latest in a long running series of regional meetings in Numerical Analysis/Scientific Computing/Applied Mathematics that typically include a mix of researchers in application domains and researchers who specialize in numerical analysis and scientific computing.

The 2015 Bluenose workshop will be held over two days in order to expand the usual regional participation to include participants from the IFIP Working Group on Numerical Software and participants (faculty and students) from the AARMS Summer School. The primary mode of participation will be a research presentation, but, in order to allow active participation by as many students as possible, both regional students and students from outside the region, there will also be a poster session during the workshop, giving students a featured forum in which to present their research.

The themes for the workshop will include "Software and Tools for Reliable Mathematical Modelling in Scientific Computing", "Waves and Patterns in Nonlinear Systems", "Reaction-Diffusion Systems", "Structure Preserving Discretization of Differential Equations", and "Numerical Analysis of Singularly Perturbed ODEs and PDES", but talks and posters in other areas of applied and computational mathematics and scientific computing will be welcome.

The IFIP Working Group 2.5 Business meeting and the Bluenose workshop are being organized by Paul Muir (Saint Mary's University), Wayne Enright (University of Toronto), and Morven Gentleman (Dalhousie University), and are supported by AARMS, the Fields Institute, and Saint Mary's University.

Further details regarding the Bluenose Workshop will be posted at the workshop website:
www.fields.utoronto.ca/programs/scientific/15-16/bluenose/

News

Domain Decomposition Methods for the Parallel Solution of Partial Differential Equations

Domain decomposition methods for the numerical solution of PDEs comprise a field of intense activity driven by the need for the efficient solution of mathematical models of physical phenomena of ever increasing complexity. These methods are designed to make efficient use of high performance, parallel computing systems. The upcoming workshop will be presented by the AARMS Collaborative Research Group in Numerical Analysis and Scientific Computing and will be held at Dalhousie University August 4–8, 2015. The workshop is timed to begin after the completion of the 2015 AARMS Summer School. The workshop will have three primary components:

-   A two–day short course on domain decomposition methods for the numerical solution of PDEs.
-   A day of problem presentations by researchers in applied and industrial fields highlighting computational difficulties and opportunities for which domain decomposition methods may be applicable.
-   A two–day interactive program bringing together experts in domain decomposition methods for PDEs with practitioners in applied fields (and associated graduate students and post docs) to investigate the use of domain decomposition methods for PDEs in applied problems in various disciplines.

The intensive two–day short course will be taught by Prof. Martin Gander from the University of Geneva. Prof. Gander is an internationally recognized leading expert in Schwarz methods - a class of domain decomposition methods for steady state and time dependent PDEs. Two other domain decomposition experts who have confirmed their participation in the workshop are:

 - Victorita Dolean (Nice)
 - David Keyes (King Abdullah University of Science and Technology)

This workshop is organized by the AARMS Collaborative Research Group in Numerical Analysis and Scientific Computing: Ronald D. Haynes (MUN), Hermann Brunner (MUN), and Paul Muir (Saint Mary's), with additional local organization from David Iron (Dalhousie), and is supported by the MUN Conference Fund, AARMS, and Dalhousie University.

Further details regarding the workshop will be posted to the workshop website: www.math.mun.ca/anasc/ddworkshop.html.

Fredericton Student on Gold-Winning Mathematics Olympiad Team

This year's Canadian Team for the International Mathematical Olympiad won gold, silver and bronze and included Fredericton Student Antonio Molina. Antonio had also previously attended two of the CMS-AARMS Math camps at UNB and this year is enrolled in his undergraduate degree at the University of Waterloo.

Antonio Molina, fifth from left

The International Mathematical Olympiad is the world championship high school mathematics competition. The 2014 IMO contest was set by an international jury of mathematicians and was written on July 8 and 9. On each day of the contest, three questions had to be solved within a time limit of four and a half hours.

Although students compete individually, country rankings are obtained by adding the team scores. The maximum score for each student is 42 and for a team of six students the maximum is 252. The Canadian team placed 9th out of 101 competing countries with an overall score of 159. The 2014 results bring Canada's total medal count since 1981 to 27 gold, 47 silver, and 80 bronze.

The Canadian Mathematical Society (CMS) is responsible for the selection, training and overall support of Math Team Canada to the IMO.

Some News from UNB

Postdoctoral Fellow Tim Koslowski and his collaborators published a paper in which they discovered that "time" arises as a mathematical consequence of Newtonian gravity. This has already got some press -- it was an Editor's pick in a prestigious journal (Physical Review Letters) and is a featured article in an American Physical Society publication, and a few other places: http://physics.aps.org/articles/v7/111. And, Professor Sanjeev Seahra has created a simulation of a model of infection spread (due to Lin Wang) to internet memes. The simulation is on youtube: https://www.youtube.com/watch?v=vEhAkEPwESI

MUN Professors Appointed New Editors-in-Chief of CMS Bulletin

Jie Xiao

Xiaoqiang Zhao

At the summer meeting in Winnipeg, the CMS Publications Committee voted unanimously to appoint Jie Xiao and Xiaoqiang Zhao, both of Memorial University, to the position of Editors-in-Chief of the Canadian Mathematical Bulletin based on their scientific achievements in their respective areas, their standing in the community, and also their relevant experience in editorial matters. Congratulations to Jie and Xiaoqiang, and it is nice to know that the Editorial Office of the CMB will be moving to Atlantic Canada.

AARMS PDF Jonathan Ziprick Reports

Over the last hundred years our understanding of nature has been radically altered by two revolutionary theories: general relativity (GR) and quantum mechanics. A major challenge for physics in the twenty first century is to bring these two disparate theories together into a quantum theory of gravity. Since there are currently no useful experimental results for quantum gravity, we must rely solely upon mathematics to advance this research.

The quantization of GR presents a new, conceptually difficult problem. The current understanding of quantum mechanics is built upon a *fixed* spacetime geometry, while the degrees of freedom in GR are those which *determine* the spacetime geometry. In other words, current methods of quantization effectively turn gravity off. In order to understand quantum physics with gravity turned on, we must find a way to treat these geometrical degrees of freedom quantum mechanically. This is the focus of my research, and I am grateful to AARMS for supporting my work along these lines as a post-doc in the gravity group at the University of New Brunswick.

Spacetime can be foliated into spatial hypersurfaces, and from this perspective the dynamics of gravity is seen as the evolution of spatial geometries. In loop quantum gravity (LQG), one of several approaches to quantum gravity, the states which span the Hilbert space describe a discrete spatial geometry. One of the main results of my work as a PhD student at the Perimeter Institute / University of Waterloo was finding an isomorphism between piecewise-flat, continuous spatial geometries for GR and the data which parameterizes the discrete geometries of LQG. In a recently completed project (arXiv:1409.7455), I used piecewise-flat geometries to study the dynamics of a simple model of gravity where point particles move within a 2d spatial hypersurface, and showed that the GR and loop gravity descriptions are consistent. In current work with Jack Gegenberg we are extending these ideas to three spatial dimensions. Going from two to three dimensions is highly non-trivial since in two spatial dimensions the constraints of GR completely fix the physical degrees of freedom, while in three spatial dimensions we have infinitely many degrees of freedom (four per point). Using piecewise-flat geometries provides a simplification where the dynamics has support only upon a one-dimensional skeleton within the three-space. This makes the theory tractable and puts it in a form which may be amenable to quantization.

I have also been working with Viqar Husain on a model which has a dust matter field coupled to gravity. We have been able to find many solutions to the equations of motion, and the model has a nice form which may allow us to develop a theory with quantum interactions between gravity and matter. Along other lines, Sanjeev Seahra and I have been discussing how we may incorporate quantum gravity effects into cosmological scenarios. These effects are of particular interest because they would have observable consequences in the cosmic microwave background which could in principal be verified experimentally.

CMS Summer Meeting: Call for Proposals for AARMS-Funded Sessions

The Canadian Mathematical Society (CMS) and the University of PEI welcomes and invites proposals for sessions for the 2015 Summer Meeting in Charlottetown from June 5th to 8th, 2015. Proposals should include a brief description of the focus and purpose of the session, the expected number of speakers, as well as the organizer's name, complete address, telephone number, e-mail address, etc. All sessions will be advertised in the CMS Notes, on the web site and in the AMS Notices. Speakers will be requested to submit abstracts, which will be published on the web site and in the meeting program. Those wishing to organize a session should send a proposal to the Scientific Directors by January 30, 2015: Gordon MacDonald (gmacdonald@upei.ca) or Shannon Fitzpatrick (sfitzpatrick@upei.ca).

Session organizers may apply for funding to AARMS to defray the travel costs of invited speakers and attending students and postdocs. Maximum funding per session is $3000. Application is through the AARMS Web site (instructions below). The deadline is January 15, 2015.

AARMS will select a number of sessions which qualify for funding. Selection will be based on scientific quality, and involvement of, and relevance to, the Atlantic region. Selected sessions will be recognized at the meeting as AARMS-CMS sessions.

To submit an application, visit the AARMS web site at www.math.aarms.ca. Follow the links to Online Services, then Administration. This will tell you how to register for an online account. In this process choose the role of "proposer". Once this is done, go back to Online Services, and follow the link Conference/Workshop proposals.

Zombies at Acadia?

Earlier this year, Acadia mathematics instructor Philip Munz received a Guinness World Record. Not because he was the tallest man alive, or that he walked the longest distance over hot plates. No, Philip was among a group of grad students and mathematicians who created the first model for the spread of a zombie outbreak. The topic arose during a project for a course on mathematical modelling of infectious diseases – a class he attended as a graduate student in Ottawa. Munz and his colleagues considered zombie-ism as an infectious disease and applied their course material.

The mathematical weapons Munz used to fight the zombies included a modified S-I-R model (called S-Z-R), which contained two mass action terms, as well as the possibility for those in the Removed (R) class to become infected. The model showed two equilibria: one without zombies (disease free) and the doomsday equilibrium (everyone is a zombie). The application of a linear stability analysis showed that – in the absence of further interventions - the disease free equilibrium was unstable and the doomsday equilibrium was stable. Several potential interventions were proposed, and the research determined them to be useless. Neither quarantine nor a cure were viable options and would only delay the inevitable. Ultimately, the best strategy he determined was to arm oneself to the teeth and hit the zombies hard.

The results were published in 2009 and the research received a lot of attention from the mathematics community and media alike. Munz's zombie research resurrects each year around Hallowe'en, both in the media and in the classroom. While some students don't fully understand the mathematics involved, they're very interested in the application. Munz has presented his work to students ranging from grade 7 through grad school, and to the general public at events like Comic Con. Since presenting his findings to students and colleagues, Munz has received notifications of people having an encounter with zombies at Acadia, only to follow up on these rumours and find that it was just his students shuffling onto campus before their morning coffee.

This stock photo of a zombie is not meant to bear any resemblence to any person at Acadia University

Science Atlantic

The 37th Annual Science Atlantic Computer Science, Mathematics and Statistics Conference was held at University of New Brunswick, Saint John from October 3rd to October 4th, 2014. There were over 100 students, with 18 official teams participating in the Mathematics Problem Solving Competition and 17 official teams participating in the Programming Competition. On Friday evening, the Sedgewick Lecture entitled "Symbiotic Autonomous Mobile Service Robots" was given by Dr. Manuela Veloso from Carnegie Mellon University and was followed by a reception. On Saturday, October 4th, there were 34 research talks, 23 of them given by undergraduate students. The Blundon Lecture entitled "Doing Mathematics Through Problem Solving and Problem Posing" was given by Dr. John Grant McLoughlin from University of New Brunswick, Fredericton. The Field Lecture entitled "Dynamic Treatment Regimens: Quantitative Tools for the Personalization of Medicine" was given Dr. Erica Moodie from McGill University. On Saturday evening, the conference concluded with the banquet that included the awarding of prizes for the Mathematics Problem Solving Competition and the Programming Competition as well as awards recognizing the top presentations of the day given by undergraduate students. Also at the banquet, Dr. Merzik Kamel from University of New Brunswick, Saint John was recognized for his years of service by being inducted into the Science Atlantic Hall of Fame as an Outstanding Contributing Member for 2014.

The organizing committee for the MSCS2014 conference would like to thank the sponsors for the event: Science Atlantic, AARMS and the University of New Brunswick, as well as the other sponsors Statistical Society of Canada, CMS-STUDC, CNSC-CCSN, Pearson, UNB-SRC, Entreprise Saint John, Innovatia, NB Power, Maplesoft, JD Irving, and Planet Hatch. As well, the organizers would like to thank all those who participated and helped make this a great conference in particular our keynote speakers, the student and faculty with contributed talks, judges for the competitions and undergraduate presentations, the mentors for the research projects and the coaches of the competition teams.

Call for Proposals

We encourage mathematicians in Atlantic Canada to suggest programmes or themes for future AARMS activities in the region (workshops, conferences) and to submit all applications for funding to our online system. Proposals for short workshops are evaluated by the executive while larger conferences are referred to the Scientific Review Panel and responses will be given as quickly as possible. Proposals are usually expected to show a detailed program with a budget and a significant number of confirmed speakers. They must also include a budget table showing projected total revenues and expenses. In general AARMS is not in a position to fund indefinite continuing activities. Successful applicants will be expected to produce a report on their event. To submit a proposal please use our Online Workshops/Conferences Proposal System. Next Deadline for submission: January 15, 2015

Recent and Upcoming Events

Recent developments in the adaptive solution of PDEs
    Organizers: Ronald Haynes, Paul Muir, Hermann Brunner
    Location: Memorial University, St. John's
    Date: August 17-22, 2014
    Contact Information: Ronald Haynes

Enveloping Algebras and representation Theory
    Organizers: Yuri Bahturin,
    Location: Memorial University, St. John's
    Date: August 28 - Sept 1, 2014
    Contact Information: Yuri Bahturin

AAC Minicourse on Branch Groups: Theory and Practice
    Organizer: Y. Bahturin, M. Kochetov, E. Martinez-Pedrosa, H. Usefi
    Location: Memorial University, St. John's
    Date: September 13-19, 2014
    Contact Information: Yuri Bahturin

Atlantic Math/Stats/CS Conference
    Organizer: Mohammad Hamdan
    Location: UNB Saint John
    Date: October 3-5, 2014
    Contact Information: Mohammad Hamdan

Connecting Women in Mathematics Across Canada
    Organizers: Sara Faridi et al
    Location: Banff International Research Station
    Date: October 3-5, 2014
    Contact Information: Sara Faridi

2014 Fall Eastern Sectional Meeting of the American Mathematical Society
    Organizer: Peter Selinger
    Location: Dalhousie, Halifax
    Date: October 18-19, 2014
    Contact Information: Peter Selinger

International Symposium in Statistics
    Organizers: Brajendra Sutradhar et al
    Location: Memorial University, St. John's
    Date: July 20-22, 2015
    Contact Information: Brajendra Sutradhar

Abstract Harmonic Analysis (AHA 2015)
    Organizers: Keith Taylor et al
    Location: Dalhousie University, Halifax
    Date: August 17-21, 2015
    Contact Information: Keith Taylor

AARMS is proud to sponsor high-quality activities in Atlantic Canada which significantly enhance research and the training of graduate students.

"If I were again beginning my studies, I would follow the advice of Plato and start with mathematics."   ~ *Galileo Galilei*