Fields launches the Centre for Financial Industries pg. 6

Thematic Program on Multiscale Scientific Computing pg. 19

Fields Special Panel Discussion on Research and Innovation pg. 18
Greetings to all our readers to this summer edition of the Fields Notes. In the following pages you will find feature articles on some of the highlights from the interesting activities and events during the winter and spring. Much more information is available on our webpages.

The major thematic program for Winter 2016 was Multiscale Scientific Computing: From Quantum Physics and Chemistry to Material Science and Fluid Mechanics. It covered the many aspects of current research and applications of scientific computation, and included a variety of activities for short and longer term visitors, postdoctoral fellows, graduate instruction, and seminars. The closing days of the program featured a public lecture on April 28, 2016 by Howard Barker of Environment Canada on Numerical Prediction of Weather and Climate: From Sub-millimetre Cloud Particles to Global Warming, and a Distinguished Lecture Series (April 28-29, 2016) by Björn Engquist (U Texas, Austin), on numerical multiscale modelling. Almost immediately following was the Focus Program on Nonlocal Partial Differential Equations (May 10 - June 10, 2016). It attracted outstanding international experts and participants for its two workshops, mini-courses and an on-going seminar. The Coxeter Lecture series in this program was given by Luis Caffarelli (U Texas, Austin) from May 16-18, 2016.

The summer has now started with a big wave of activity, including the major Thematic Program on Combinatorial Algebraic Geometry from July - December 2016, with organizers David Cox (Amherst College), Megumi Harada (McMaster University), Diane Maclagan (University of Warwick), Gregory Smith (Queen’s University), and Ravi Vakil (Stanford University).

We are now preparing for the Fall 2016 Fields Medal Symposium, November 1-4, 2016, celebrating the work of Manjul Bhargava (Princeton, the first Canadian medallist). A Scientific Committee has been established, and we already have a very distinguished list of confirmed speakers (see our webpage for more details). We are grateful to our Gold Level sponsor Great-West Life and to a number of private donors for making this symposium series possible. We are very pleased to announce that Elsevier, a world-leading scientific publisher, will also be a Gold Level sponsor for the Fields Medal Symposia starting this year.

The Fields Institute has enjoyed a continuing and mutually beneficial connection with financial industries for many years. The just-announced Centre for Financial Industries is the new focal point for these activities, providing visibility for the expertise of its members, facilitating corporate collaboration and enabling rapid mobilization of resources. The Centre provides unique benefits for Corporate Members, including proposing and organizing scientific activities at the Institute with exclusive access to the results; participation in the Centre's working groups, roundtables, webinars and seminars; recruitment opportunities; and networking opportunities among the corporate membership. The founding corporate members of this Centre are the TMX Group, Scotiabank, and Sun Life Financial.

It is also a pleasure to announce the creation of a new centre for the promotion of transformative research in mathematics education. The Centre for Mathematics Education facilitates communication and collaboration with other mathematics educators and institutes both within Canada and globally through the promotion and organization of public and outreach events, education programs, and various scientific activities such as conferences, workshops, and seminars.

In addition to the distinguished lecture series included in our thematic and focus programs, the Institute also hosts and sponsors a number of public lectures. This past year we enjoyed presentations by Lisa Randall (Harvard), Double Disk Dark Matter, in the Fields-York Lecture series; two talks by Cesar Hidalgo (MIT), Seven Tools to Transform Data into Stories, and Why Information Grows: The Evolution of Order, from Atoms to Economics, as a joint lecture series with the Royal Canadian Institute; Howard Baker (Environment Canada), Numerical Prediction of Weather and Climate: From Sub-millimetre Cloud Particles to Global Warming; Allan Borodin, Conceptually simple
combinatorial algorithms, the 2016 Avner Magen Memorial Lecture (jointly with the Department of Computer Science, U of T); and Wolfgang Lutz (Wittgenstein Centre for Demography and Global Human Capital), Modelling human capital formation as the basis for assessing the benefits of education: A global perspective, as the 2016 Keyfitz Lecture in Mathematics and the Social Sciences.

On behalf of the whole Fields community, I would like to express our appreciation to Matheus Grasselli for his outstanding service as Deputy Director over the last five years. We wish him every success in his up-coming year of research and travel, and for the future. On July 1, 2016 we welcomed Huaxiong Huang in his new role as Deputy Director. Continuing our outreach for the mathematical sciences in industry will be Tom Salisbury (seconded part-time from York) as the new Associate Director for Industrial Liaison, and Pawel Pralat (seconded part-time from Ryerson) as the new Assistant Director for Industrial Liaison.

The already approved thematic and focus programs for 2017 and 2018 are listed on our webpage, and we are actively encouraging new proposals for the future. An ad hoc committee of the Board recommended that we include a “semester” or four month option in our thematic program offerings, and this will be advertised for the next round. A new program of Fields Research Fellowships are announced in this issue, to encourage longer term “scholars in residence” starting in Winter 2017. These fellowships will be for a minimum of 1 month residence, and open to excellent researchers nominated by faculty members at our Principal Sponsoring Universities. Also of interest to our community is the new partnership between Fields and Mitacs in which we will provide stream-lined access and peer review for a cluster of Mitacs Accelerate internships.

We very much appreciate the support of the Province of Ontario, through the Ministry of Research, Innovation and Science, and the Government of Canada, through the Natural Sciences and Engineering Research Council. In addition, our scientific activities are sustained and enhanced by the continuing support of our Principal Sponsoring Universities, our corporate sponsors, and the National Science Foundation.

Ian Hambleton, August 2016
DR. THOMAS S. SALISBURY HAS BEEN NAMED THE NEW Associate Director of Industry Liaison, after a search that began in the winter of 2016. Candidates for the position were encouraged to apply from all over the country, as well as internationally.

With over 30 years of experience, Salisbury is a leading figure in probability theory, specifically Brownian motion and related Markov processes, including their applications to mathematical finance and actuarial sciences.

Dr. Salisbury replaces Dr. Huaxiong Huang, who became the Deputy Director of the Fields Institute in July 2016. During his term as Associate Director of Industry Liaison (September 2014 to July 2016), Dr. Huang oversaw the implementation of the Institute’s Innovation Platform (IIP), a new collaboration between Fields, the Pacific Institute for Mathematical Sciences (PIMS) and the Centre de recherche mathématique.

Salisbury’s duties will include organizing workshops, job fairs, and events with the aim to develop a scientific environment that nurtures connections and collaborations between academic researchers and scientists in industry. He will also coordinate with the Fields Institute Industrial Advisory Board (IAB) and with the Industry Liaison counterparts at PIMS and CRM as part of the national Institute’s Innovation Platform.

In response to his goals for his position Salisbury said, “The Fields Institute is taking the lead in getting mathematicians talking to industry, and showing industry how it can make use of mathematicians. We have seen this idea in the Quantitative Finance Seminar, where the monthly Fields seminar is the main Toronto event at which academics from various institutions meet with each other. I am eager to play a key role and developing that effort further.”

Dr. Salisbury tenure as the new Associate Director of Industry Liaison will commence on September 1st, 2016.

About Dr. Tom Salisbury
Dr. Thomas S. Salisbury received his BSc from McGill University in 1979, and his PhD in mathematics from the University of British Columbia in 1983. After a postdoctoral position as a Research Assistant Professor at Purdue University, he then moved to York University where he is a Professor and former department chair of the Department of Mathematics and Statistics. He was co-editor-in-chief of the Canadian Mathematical Bulletin, and has served on the editorial boards of Probability Theory and Related Fields, Fields Institute Communications & Monographs, Potential Analysis, and the Canadian Journal of Statistics.

At York University, Salisbury teaches financial engineering and was director of analytics at Quantitative Wealth Management Analytics group (QWeMA) prior to the latter’s acquisition by CANNEX, and led the Financial Analytics project at Mitacs. In 2007, he chaired the task force that initiated the revision of the Ontario’s grade 12 curriculum, and then served on the Ontario Minister of Education’s curriculum council. He served terms as Deputy Director of the Fields Institute from 2003–2006, and as President of the Canadian Mathematical Society from 2006–2008.
ON MAY 7 2016 grade nine girls from seven school boards (TDSB, DDSB, TCDSB, YCDSB, YRDSB, PDSB, BDSB) as well as eight independent schools (Bond, Centre for Jewish Education, Coucel Scolaire Viamonde, Canadian Accredited Independent Schools, UMEI Christian High School, Branksome Hall, Pickering College, North Toronto Christian School), attended Math In Motion … Girls in Gear!, at UTSC (University of Toronto Scarborough).

The students started the day being introduced to each other by joining large groups and attempting to solve an open ended question. The introduction was given by Lana Paton of PwC. The girls then attended two of four different hands on sessions, presented by Anya Tafllovich, UTSC, Judith Koeller, University of Waterloo, Bernice Chan & Corinna Bellomo, IESO, and Caitlin Partridge, Honda Canada Inc. The hands on sessions were followed by lunch, where the girls ate and also worked in small teams to create pieces of a larger banner. The popular design challenge followed, were teams of 4 students had to make robust carriers to both protect their cargo and fly precisely in the air in order to land on the designated target.

The event was attended by Tracy MacCharles, MPP, Pickering – Scarborough East. After the design challenge, a group photo was taken in the atrium, with the banner the girls had made displayed. The keynote speaker was Premier Kathleen Wynne, who was greeted by Bill Gough, Interim Vice-Principal Academic and Dean, and introduced by David Fleet, Department Chair Computer and Mathematical Sciences, University of Toronto Scarborough. “I’m particularly excited about today,” said the Premier. “It demonstrates to me that we are well on our way to the day when men and women can make an equal contribution across all fields, the day when ‘first woman’ doesn’t come before any job title in the province.” Premier Wynne spent part of her time answering thoughtful and pertinent questions from the students.

The day ended with the results of the large groups challenge and the design challenge and presentations made to the top group and teams.

The organizing committee is comprised of a Professor, teachers from TDSB and DDSB and two undergraduate UTSC students. Minty Zhang has volunteered for the past four years. Lisa Shao attended Math in Motion … Girls in Gear! in grade nine, volunteered for the past four years at UTSC, and this year was in charge of the volunteer students. Although the majority of the volunteers were UTSC undergraduate students, three mingig alumni (in fourth year from other universities) also joined the day to help.

As a committee, we always to strive to balance our budget and not spend more than we have. Although it is our desire to provide reusable water bottles, this year the funds were not available and instead we used bottled water. We would like to thank all our sponsors, especially the Fields Institute (Lunch), UTSC: Registrar’s Office (Postage), Dean’s Office (Mailout), Lana Paton, Google (prizes and loot bag items), and IESO.

Judy Shanks (Pickering High School, DDSB)

Photos courtesy of Ken Jones, UTSC Communications
The Fields Institute launches the Centre for Financial Industries

TMX
Scotiabank
Sun Life Financial

THE FIELDS INSTITUTE IS PROUD to introduce the Centre for Financial Industries, designed to focus and enhance collaborations and exchanges of expertise between the mathematical community and leading financial firms of all types – including banks, insurance companies, exchanges, investment firms, and consultants.

The Centre will act as a focal point for financial research in North America, with individual members who come from a community of academics and practitioners who regularly participate in activities at the Fields Institute. These members can include, but are not limited to, faculty members and postdoctoral fellows from Fields’ Principal Sponsoring Universities, practitioners from the local financial industry, regulators and public officials, as well as Canadian and international scientists with close ties with the Institute. This creates a broad spectrum of interests that are included in the new Centre to increase Fields impact in the finance industry.

The breadth of academics, practitioners, and prominent scholars who regularly participate in Fields activities come from over twelve Canadian Universities, and over sixty international universities, institutions, and corporate sponsors. This exemplifies Fields diversity and focus on the application of mathematics to global financial analysis. One of the initiatives of the Centre is to expand Fields further, and increase the number of universities and corporate affiliates so the Centre for Financial Industries can grow along with the Fields Institute.

With this goal in mind, we are proud to announce the TMX Group (the parent company of the Toronto Stock Exchange), Scotiabank, and Sun Life Financial, as the initial group of Corporate Members of the Centre.

“TMX Group is pleased to be a founding member of the Centre for Financial Industries at the Fields Institute,” says Jean Desgagné, President and CEO, Global Enterprise Services, TMX Group. “We see great value in connecting and collaborating with leaders from the academic community and Canada’s financial services sector. The mobilization of our collective resources can play an important role in advancing our industry and strengthening Canada’s economy.”

Mark Engel, Senior Vice President, Risk and Capital Analytics, Scotiabank says “Scotiabank is proud to participate as a founding corporate member in the Centre for Financial Industry at the Fields Institute. The Centre’s activities – bringing together world class researchers and leading industry practitioners to advance quantitative finance and find innovative industry applications of analytics – will provide excellent opportunities for collaboration in support of Scotiabank’s focus on innovating for our customers.”

Claude Accum, Executive Vice-President and Chief Risk Officer, Sun Life Financial stated that “being a member of the Centre and having the opportunity to work with leaders across North America in the academic, public and private sectors is a great benefit to everyone involved.” The Centre’s influence will be felt by many factions of industry, but Accum stated further that as an organization Sun Life Financial “is centred on helping clients achieve lifetime financial security, which can’t be accomplished without continuous research, innovation and understanding evolving financial trends.” These trends will be one of the research mandates of the Centre as a whole.

The activities that will take place at the Centre for Financial Industries derive from previous experience and the goal is to solicit, promote, and organize seminar series, workshops, conferences, summer schools, short and long thematic programs, mini-courses, training activities, graduate courses, public lectures, and outreach events taking place either at the Fields Institute or at any of its partner Universities or other institutions in Canada or abroad. “Since its inception, the Fields Institute has played a major leadership role in quantitative finance, bringing together researchers and industry practitioners at the intersection of finance, economics, mathematics and technology” says Matheus Grasselli, former Deputy Director of the Institute and a member of the Centre’s Steering Committee. “Quantitative Finance has been a core part of the Institute’s Commercial and Industrial Mathematics Program, including a world-renowned monthly seminar series, running now for over two decades, a highly successful six-month thematic program in 2010, numerous workshops, conferences, short courses, career fairs, and industrial-academic events. In addition, it has served as the incubation platform of several successful financial services and FinTech start-ups.”

At the public announcement of the Centre, which took place during the Institute’s 2016 Annual General Meeting, Dan Rosen, the first Director for the Centre, stated that “The new Centre for Financial Industries advances the Institute’s world-leadership role in Quantitative Finance and Analytics, serving as a focal point for future activities in this area. We believe that the future is all about collaboration, and thus the Centre provides the space for bringing top academic researchers, students, and industry closer together…and define the direction of practical research and educational activities, and get also access to recruit the brightest young talent.” This mandate will be key in the development of the centre as a whole.

Editors of Fields Notes
THE LAST TWO DECADES have witnessed the “coming of age” of mathematical oncology as a discipline, and it has now firmly taken center stage as one of the major themes of modern applied mathematics. However, to be useful, mathematical models should be coupled with experimental investigations and clinical practice, and should be integrated into the existing body of knowledge and wisdom accumulated in oncology. It seems clear that progress in this field, so interdisciplinary in nature, will depend critically on the ability of team members to speak a common language. There needs to be a spirit of mutual understanding and appreciation amongst teams composed of experimental, clinical and theoretical scientists, and an open forum for alternative views and stimulating new ideas.

The workshop “Mathematical Oncology VI: Quo Vadis? - The interplay of Theory, Experiment and Clinical Practice” was held April 11-13, 2016 at the Fields Institute. The program was co-ordinated by the Centre for Mathematical Medicine (CMM) but was an international meeting, attracting some of the leading figures in the field. The workshop brought together a balanced international group of both mathematical and experimental/clinical scientists working at the forefront of the interdisciplinary field of mathematical oncology. The workshop also formed part of the 10th anniversary celebrations of the establishment of CMM at the Fields Institute.

The workshop featured a number of invited talks as well as selected contributed talks with an excellent balance between theory and experiment, and the topics covered a broad spectrum of problems of current interest in oncology. These included talks by leading Canadian scientists/physicians: John Dick (Princess Margaret Cancer Centre, Modelling the development of human leukemia), Michael Milosevic (Princess Margaret Hospital, Quantifying hypoxia in human cancers), Richard Hill (University Health Network, Tumour microenvironment and treatment response), and Sheila Singh (McMaster University, Role of radiation-induced non-targeted effects in radiation protection and therapy), as well as established international scientists Aaron Goldman (Harvard Medical School, Therapeutic strategies of childhood medulloblastoma: strategies for blocking recurrence) and Sendurai Mani (MD Anderson Cancer Centre, Identification and targeting of cancer stem cells) who are all pioneers in the field of cancer biology. Theoretical talks included presentations by Eduardo Sontag (Rutgers University, Incoherent feedforward motifs as immune change detectors), Natalia Komarova (University of California, Irvine, Calculus of stem cells), Carl Panetta (St. Jude Children’s Research Hospital, Sorafenib physiologically based pharmacokinetic modeling: a case study in model evaluation approaches), Gibin Powathil (Swansea University, Role of radiation-induced non-targeted effects in radiation protection and therapy) and Kevin Leder (University of Minnesota, Optimizing chemo-radiotherapy to target multi-site metastatic disease). All speakers gave distinct perspectives on their particular areas of research in theoretical, experimental and/or clinical aspects of cancer – in short, all the talks were excellent and inspiring. They all point to the very real prospects of dramatic advances and breakthroughs in clinical oncology, brought about through this interdisciplinary interaction of the mathematical sciences and oncology/cancer biology, which is the burgeoning field of mathematical oncology.

In summary, we believe that the workshop was very successful and brought together the experimental sciences (cancer biology, clinical oncology) and the mathematical sciences under a single umbrella to discuss a broad spectrum of problems of current interest in oncology.

Mohammad Kohandel (Waterloo)
The workshop Quantum Groups in Quantum Gravity (QG) aimed at bringing together theoretical physicists and mathematicians sharing an interest for the emergence of deformed symmetries (so-called Poisson-Lie groups and quantum groups). A large part of the contributions focused on the emergence of such deformed symmetries in the context of different approaches to quantum gravity: canonical and covariant loop quantum gravity, three-dimensional quantum gravity coupled to particles, string theory and AdS/CFT, non-commutative geometry, etc. Such a variety of approaches is rarely encountered at other conferences and workshops, which usually focus around a common approach to the problem, rather than around a recurrent theme or mathematical tool.

It was exactly this idea, of gathering people from different backgrounds, but speaking a common language that motivated our proposal. The resulting experience has been more than positive, and the conversations between researchers extensive. This was made possible by our decision of reducing the number of talks in favor of longer discussion times, in both formal and informal contexts. This was a crucial component to the success of our workshop, which revived old collaborations and, above all, spurred new ones.

The large spectrum of topics, as well as the technical level required to understand them, called for introductory lectures made by specialists. Consequently, four mini-courses (of two lectures each) were put in place to set a common basis for the more technical seminars and discussions. Typically, the lecturers prepared a first lecture that was very introductory and then covered more advanced topics in the second lecture, so that both students and researchers could benefit from them. These lectures attracted many master and PhD students from the University of Waterloo, Perimeter Institute (PI), and the University of Toronto. A few students also came from the United States and Europe. There were about 50 participants at the workshop.

We conclude, by highlighting what were some of the most interesting moments of the workshop. To start with, we have to emphasize, once again, the high quality of the four mini-courses held by world-class specialists: Introduction to Categories and TQFT by J. Barrett, Introduction to Poisson-Lie groups by E. Meinrenken, Introduction to 3d Quantum Gravity by C. Meusburger, Introduction to Quantum Groups by S. Majid. All the lectures were recorded and will be soon available online.

Talks by B. Schroers (H. Watt U), S. Carlip (UC Davis), and H. Verlinde (Princeton U) successfully conveyed their viewpoints on three-dimensional quantum gravity to an audience mostly versed in loop quantum gravity. New and exciting developments in loop quantum gravity were presented by M. Geiller (PI), M. Han (Florida Atlantic U), and V. Bonzom (Paris 13), just to name a few.

The University of Waterloo provided us with a workshop room in the Institute of Quantum Computing. Excellent lunches and coffee breaks were also provided, which contributed to the development of lengthy and productive discussions.

The workshop could not have happened without the generous support of our sponsors, The Fields Institute, The University of Waterloo, The Perimeter Institute, NSERC, and the Ontario Government.

Florian Girelli (Waterloo)
Workshop on Flavours of Gauge Theory

Rubermania! On the Occasion of Daniel Ruberman’s 61st birthday
May 6-8, 2016, The Fields Institute

Over 40 participants from four different countries (Canada, Korea, Slovenia, USA) came to the Fields Institute in this three-day workshop, sponsored by the Fields Institute, the National Science Foundation, and Brandeis University. The workshop was held on the occasion of Daniel Ruberman’s 61st birthday, and the range of topics was attesting to his many research interests and accomplishments.

The scientific programme consisted of 12 invited lectures from leading experts as well as younger researchers in gauge theory and low-dimensional topology. Over half of the workshop participants were early career mathematicians, including 13 graduate students from various universities (Brandeis, Bryn Mawr, Indiana, Kansas State, McMaster, Michigan State, Toronto, UCLA, and Virginia) and 10 postdoctoral fellows (from Brandeis, the Institute for Advanced Study, Kansas State, Kentucky, McMaster, Miami, Princeton, and UCLA). The financial support from the Fields Institute, the National Science Foundation and Brandeis was critical, and enabled us to provide travel support for all the early career mathematicians in attendance. The workshop stimulated a positive exchange of ideas between all the participants.

Over the last 30 years, gauge theory has provided a string of stunning breakthroughs in geometric topology, including the existence of exotic smooth structures on 4-manifolds and the resolution of many open questions about 3-manifolds, knots and links. The toolkits used by gauge theorists have evolved over time, from Donaldson invariants, which involve the Yang-Mills equations on SU(2) bundles, to the Seiberg-Witten invariants, which use monopole equations on U(1) bundles, to the more computationally accessible Heegaard-Floer invariants of Ozsváth and Szabó. The associated moduli spaces, which are the solution sets of these equations up to gauge equivalence, carry deep topological information about the manifolds and their embedded submanifolds, and have been used to unravel many riddles in geometric topology. For example, one of the most spectacular recent breakthroughs is Ciprian Manolescu’s resolution of the triangulation conjecture in high dimensions. In his talk, a major highlight at the workshop, Manolescu described his new homology cobordism invariants for homology 3-spheres, dened using Pin(2) equivariant Seiberg-Witten Floer homology. He outlined how to apply the Pin(2) equivariant machinery to disprove the triangulation conjecture, producing non-triangulable manifolds in all dimensions five and higher. This is a spectacular result that culminates years of active investigation.

Another one of the highlights of the workshop was Tom Mrowka’s talk, where he discussed joint work with Peter Kronheimer toward an instanton Floer homology theory defined for spatial graphs and a promising potential application to giving a new proof of the four-colour theorem. The four-colour theorem was first established in 1976 by Kenneth Appell and Wolfgang Haken via a computer-aided proof, and was not initially accepted by all mathematicians. There is considerable excitement over the programme of Kronheimer and Mrowka because it holds the promise of providing the first mathematically rigorous, non computer-aided proof of the four-colour theorem.

The other talks at the workshop were equally exciting: Khovanov homology and knot Floer homology for pointed links (Adam Levine); Small exotic 4-manifolds via positive factorizations in the mapping class group (Ian B. Lewis); Periodic eta invariants and the Furuta-Ohta conjecture for mapping tori of finite order (Nikolai Saveliev); The Thom conjecture for CP^2 (Sašo Strle); New examples of 3-manifolds not obtained as surgery on a knot via obstructions from Heegaard Floer homology (Jen Hom); Knot theory and complex curves in subcritical Stein domains (Matt Hedden); Involutive Heegaard Floer homology (Kristen Hendricks); Knot theory, corks, and equivariant cobordism (Dave Auckly); Positive-definite symplectic 4-manifolds and exotic smooth structures (Tye Lidman); and Traceless SU(2) character varieties of tangles and punctured spheres (Paul Kirk).

Dave Auckly (Kansas State)
Hans Boden (McMaster)
Paul Melvin (Bryn Mawr)
This past May, the University of Ottawa hosted the Workshop on Hecke Algebras and Lie Theory. The four-day activity, which took place between May 12 and May 15, was enormously successful in drawing the attention of the research community in Lie theory and Hecke algebras: it attracted more than 50 local and international participants at all levels, from prominent established researchers to aspiring and enthusiastic graduate students and postdoctoral fellows. The workshop featured three minicourses and over a dozen research talks by speakers from Canada, Germany, Israel, the Netherlands, and the US, which spanned a broad spectrum of topics that belong at the forefront of research in Hecke algebras and Lie theory.

The idea of organizing this workshop was conceived during a fruitful collaboration of the organizers on a project about the spectrum of invariant differential operators on symmetric pairs of Lie superalgebras. From this work, and several other recent results, it is natural to infer that a profound connection between Lie superalgebras and the theory of Double Affine Hecke Algebras (DAHA) should exist. Further, in a different direction, the work of one of the organizers (Siddhartha Sahi) with one of the minicourse lecturers (Bogdan Ion) establishes many ties between the DAHA and Extended Affine Lie Algebras (EALA). Interactions between the aforementioned areas lead to a plethora of questions, and answering them necessitates the expertise of researchers in more than one field. The goal of the workshop was to facilitate and expedite collaboration among experts in the three areas of DAHA, EALA, and Lie superalgebras. In this respect, the three minicourses on DAHA (by Bogdan Ion), EALA (by Erhard Neher), and Lie superalgebras (by Vera Serganova), were planned to bring everyone up to speed before the research talks would begin.

In addition to being a unique occasion to learn about cutting-edge research, the workshop was also an opportunity for several outstanding junior participants to present their own work. Three postdoctoral fellows were offered 30-minute time slots to give talks. A novelty of the conference was a two-hour poster session for several 35 graduate students and postdoctoral fellows who attended the workshop, close to 25 were from outside the Ottawa area. All of the non-local junior participants received financial support for the reimbursement of their travel and accommodation expenses. The generous and timely grant by the National Science Foundation was essential in sponsoring 15 junior participants from American institutions.

After the conference, an anonymous online survey was conducted to solicit feedback from the participants on the novelties in the structure of the activity (such as the minicourses taking place before the research talks, and the inclusion of a poster session). The responses were highly positive: a clear indication that the new format was functioning and might be suitable for our future workshops.

In the past seven years, University of Ottawa Lie theorists have played an active role in organizing workshops associated to the Network on Ontario Lie Theorists (NOLT). Since its inception in 2009, the mission of NOLT has been to sponsor mathematical collaboration and increase the visibility of Lie theory within the larger mathematical community. The Workshop on Hecke Algebras and Lie Theory successfully continued the University of Ottawa’s long and thriving history of hosting major events in Lie theory and related areas.
THE 7TH BIENNIAL MEETING on Systems and Control Theory took place on May 11-13, 2016, at Queen's University. There were close to 100 participants at the meeting, the majority being graduate students and post-doctoral researchers. The participants were predominantly from Ontario, Quebec, and New York. The conference involved 50 minute faculty talks and 30 minute student and postdoc talks, with priority given to junior professors and post-docs. There was also a poster session.

These meeting series has become a major recurring scientific activity for researchers and graduate students in control theory in Canada. The first such meeting was held in May 2004 at Queen's University with subsequent meetings at Toronto and Waterloo, then rotating between these three institutions. These meetings have proven an effective way of enhancing the collaboration among the Canadian control theory community and raising the profile of control theory in Canada.

While systems and control theory is a subject that is presently driven by applications, one of the selection criterion for talks at this meeting was that the research presented had a theoretical and foundational component so as to make the presentation as broadly interesting as possible for a diverse audience. As envisioned, the talks touched upon fundamental aspects of control theory. In this year's meeting, the talk topics were mainly clustered in the areas of decentralized control, geometric control, and stochastic control. Talks touched upon mathematical aspects from differential geometry, functional analysis, graph theory, and probability theory, and the applications to controllability, optimal control, stabilizability, optimal stochastic control, decentralized optimization, and game theory.

To help support the meeting, Fields provided $5,000, and Queen's University added $1,500. The support of Fields was used entirely to support the accommodation and travel costs for graduate students and post-doctoral researchers, whereas the local support was utilized for service costs at the meeting.

Serdar Yüksel (Queen's University)
The Workshop on Homotopy Type Theory and Univalent Foundations of Mathematics took place from May 16 to 20, 2016 at the Fields Institute. With over 100 participants, it was the biggest Homotopy Type Theory and Univalent Foundations event to date.

Homotopy Type Theory is a new area of research, combining homotopy theory (a branch of topology) and type theory (a formal logical system studied in computer science and logic). It is based on the idea that the logical notion of equality can carry more information beyond its truth value and as such may resemble the notion of homotopy between continuous maps. The result is a rich theory, capable of being used in the study of a wide variety of mathematical topics, ranging from homotopy theory and higher category theory, to algebra and analysis. In addition to providing a new viewpoint on these subjects, it also provides a framework in which proofs can be formally verified by a computer.

Homotopy Type Theory has seen a surge of interest recently, with over 50,000 downloads of The HoTT Book, an introductory textbook on the topic, and a large number of reading seminars held around the world. However, it can be a difficult area for beginners to break into, as it requires familiarity with several areas of mathematics. For that reason, we decided to ask four leading researchers to give mini-courses on areas of active research in Homotopy Type Theory:

1. Robert Harper, Department of Computer Science, Carnegie Mellon University, Computationa Higher Type Theory;
2. Daniel R. Licata, Department of Mathematics and Computer Science, Wesleyan University, Cubical type theory;
3. Peter LeFanu Lumsdaine, Department of Mathematics, Stockholm University, Homotopy-theoretic models of type theory;
4. Michael Shulman, Department of Mathematics and Computer Science, University of San Diego, Synthetic homotopy theory

These mini-courses assumed some familiarity with the basics of Homotopy Type Theory, and surveyed the main results, techniques, and open problems in their respective topics.

In addition to the mini-courses, we had 5 invited talks and 17 contributed talks, which covered many exciting recent developments in the fields. The invited talks were Benedikt Ahrens, Categorical structures in type theory, in type theory; Thorsten Altenkirch, Why does Homotopy Type Theory matter?; Jeremy Avigad, Homotopy Type Theory in Lean; Emily Riehl, Towards a synthetic theory of (1: 1)-categories; and Michael Warren, Directness in type theory.

Thanks in large part to the mini-courses, we saw many non-specialists participating in discussions of open problems and contributing many interesting ideas and viewpoints. Our workshop clearly marks the beginning of many new collaborations.

None of this would be possible without the generous support of our sponsors: The Fields Institute, The National Science Foundation, The Pacific Institute for the Mathematical Sciences, The Atlantic Association for Research in the Mathematical Sciences, and The Faculty of Science at The University of Western Ontario. Their contributions made it possible for us to provide (at least partial) funding for over 50 of the participants, primarily graduate students and postdocs.

This event will surely have a lasting impact on the future development of the field, and we would like to thank The Fields Institute and its staff for making it possible.

Dan Christensen (The University of Western Ontario)
THIS YEAR SAW RETURN of the GAP (Geometry and Physics) series of conferences to the Fields Institute, the site of its third instalment in 2011. This year’s conference, which ran from May 17 to 20, was appropriately titled “Beginnings and Ends of Moduli Spaces”, as the talks were organized around new developments in the local and global structure of moduli spaces that reside at the intersection of mathematics and physics.

The invited speakers were Davide Gaiotto (Perimeter Institute), Eric Korman (University of Texas at Austin), Alexander Soibelman (MPI Bonn / University of Southern California), Hartmut Weiss (Christian-Albrechts-Universitaet Kiel), and Dan Xie (Harvard University). Each speaker contributed two talks, with the aim of making cutting-edge ideas and results accessible to students.

The moduli space of Higgs bundles on a Riemann surface, known as the Hitchin system, received a large amount of attention in the talks. This was natural given the recent work of Gaiotto-Moore-Neitzke and Mazzeo-Swoboda-Weiss-Witt on the hyperkaehler metric on the Hitchin system and the work of Haydys and Hitchin on constructing a canonical hyperholomorphic line bundle on it. Hartmut Weiss gave two talks on understanding the hyperkaehler metric via “limiting configurations” --- solutions to an asymptotic version of Hitchin's self-duality equations, the gauge-theoretic source of Higgs bundles. Both Alexander Soibelman and Dan Xie discussed new ideas in the geometry and physics, respectively, of moduli spaces of quiver representations. Soibelman and Davide Gaiotto introduced different ways in which versions of the Hitchin system tie into the Geometric Langlands Program, and both Gaiotto and Xie discussed moduli-theoretic interpretations of dualities in physics involving the Coulomb and Higgs branches of super-conformal field theories. Finally, Eric Korman discussed properties of parabolic Higgs bundle moduli spaces and geometric structures on them, including a natural analogue of the Haydys-Hitchin bundle.

The lively conference was attended by 36 registered participants. Apart from Toronto-based attendees, there were participants from the University of Manitoba, McGill University, McMaster University, Michigan State University, Northeastern University, the Perimeter Institute, Rutgers University, the University of Waterloo, and the University of Western Ontario. More striking than the geographic distribution of the participants was the range of academic ranks present: in addition to faculty (including emeritus faculty), there were postdoctoral fellows, PhD students, MSc students, and even undergraduates present!

Participants appreciated the lengthy discussion sessions between the talks. Small discussion groups formed organically, utilizing the Institute’s foyer and classrooms to wrestle with the new ideas from the talks. The Institute was a perfect venue for this kind of conference, allowing us to place equal emphasis on organized talks and free-form discussion. Of course, participants also appreciated the many amenities in walking distance of the Institute.

We would like to thank Ian Hambleton and Matheus Grasselli for their support, as well as Spiro Karigiannis for assistance and advice. The conference could not have proceeded so smoothly without the hard work of Esther Berzunza, Mimi Hao, and Adnan Zuberi at the Fields Institute. Finally, we wish to acknowledge the support of NSERC, the Government of Ontario, and the NSF for crucial funds received through the Fields Institute’s General Scientific Activity program.

Organizing Committee: Steven Rayan (University of Saskatchewan), Marco Gualtieri (University of Toronto), Ruxandra Moraru (University of Waterloo), McKenzie Wang (McMaster University).

Steven Rayan (University of Saskatchewan)
ArtSci Salon
September 24 - May 4, 2016, The Fields Institute

ArtSci Salon is a series of events facilitating discussion and cross-pollination between science, technology and the arts, curated by Roberta Buiani and Stephen Morris. ArtSci Salon responds to the recent expansion in the GTA of a community of scientists and interdisciplinary/media artists, increasingly seeking collaborations across fields to successfully accomplish their research projects and inquiries. Our meetings are attended by members of the scientific and the arts community and go from 6:00 pm to 8:00 pm. Our ultimate goal is to evenly mix art-science debates and site-specific performances and exhibitions at The Fields Institute and at other venues in its proximity, an ambition that we hope to turn into a reality in the Fall 2016 when we will be collaborating with Drama and Music.

ArtSci Salon is gradually expanding its activities. In 2015, we joined the Leonardo/The International Society for the Arts, Sciences and Technology (Leonardo/ISAST), an organization that serves the global network of scholars, artists, scientists, researchers and thinkers through programs focused on interdisciplinary work, creative output and innovation. Thanks to this membership, we have been able to disseminate our events internationally under the title of ArtSci Salon/LASER Toronto. During 2015-16 year, two of our current events were attended remotely by artists and scientists based in California and Texas. In January 2016, we launched the first ArtSci Salon exhibition featuring art and science collaboration at the Redhead Gallery, an arts venue with an interdisciplinary mandate and a keen interdisciplinary interest. The exhibition, which ran for 2 weeks, displayed the works of Stephen Morris and Ron Wild and received excellent reviews and media publicity. For the occasion, we held our ArtSci Salon at the gallery with physicist Kari Dalnoki-Veress. The event was a success.

Our events are well attended (between 30 and 45 attendees) and have generated intriguing interdisciplinary discussions so far. Below is a list of the events (events marked with * are LASER/Toronto events; exhibition is marked with **):

September 24th, 2015
Make, do, think: new forms of literacy to make sense of the world with Sylvia Adamcik, Antonio Gamba-Bari (UofT)
With this first Fall-Winter ArtSci Salon event, Sylvia Adamcik and Antonio Gamba-Bari explored new forms of literacy through interdisciplinary approaches that incorporate science, artistic expression, and DIY and making initiatives. Specifically, they engaged with the following questions: how can we grasp the significance of global scale phenomena such as climate change, environmental pollution or technological saturation at a local, micro, and personal level? Can we develop a civic science that promotes awareness and enables communities to become active evidence-seekers and, themselves, sustainable producers?
November 11th, 2015
**Revealing Neutrinos with Mark-David Hosale (York), James Madsen (UWM)**

Dr. Hosale and Dr. Madsen discussed the Art/Science processes of collaboration and the challenges in exploring the visualization and sonification of data sets collected at the IceCube Neutrino Observatory, a new type of telescope made from one cubic kilometer of ice starting one and half kilometers below the surface at the South Pole. Hosale and Madsen have been working regularly with each other since 2012 and have realized several projects including Quasar2 and 3, an international art/science panel discussion at Deutsches Museum in Munich, Germany, and a variety of education and outreach projects. Their current work is the product of a collaboration between the Wisconsin IceCube Particle Astrophysics Center and the nD::StudioLab at York University.

November 19th, 2015

*B Data Imaginaries Graham Wakefield (York), Haru Ji (York), Christopher Collins (UoIT)*

We often think of data as quantitative variables or as discrete pieces of information that bear little or no cultural significance in their assumed "raw" state. With the increasing digitalization of every aspect of today's life, they have become crucial not only in understanding trends, behaviours, phenomena etc., but also in initiating reflections on their very nature. A lot has been written about the politics and ethics involved in collecting data, and the ways in which data are endlessly and invisibly seized thanks to algorithms and technological devices. Conversely, little attention has been given to the creative processes employed, the artistry that goes into making them meaningful and, often, beautiful, or the conceptual reflections that data collection as an activity evokes. During this ArtSci Salon, we interrogated this latter aspect by presenting diverse, though ultimately converging perspectives and practices of artists Graham Wakefield and Haru Ji, and computer scientist Christopher Collins.

December 3rd, 2015

*Icicle Music Jimmie LeBlanc (McGill), Fareena Chanda, Stephen Morris (UofT)*

"Ice" is a collaboration between composer Jimmie LeBlanc, media artist Fareena Chanda and physicist Stephen Morris exploring the formation of icicles. In this project, projections, live performance and music show the constantly changing state of ice, and turn its formation into an event that can be perceived multisensorially, rather than just visually. Beyond the poetry and the aesthetics evoked by this project, one is wondering whether similar practices hold the potential offer new ways to observe, perceive and understand natural phenomena. "Ice" was premiered by Continuum Ensemble at the Subtle Technologies Festival 2015.

January 20th-30th 2016

**The Map and the Territory: An Exhibition at Red Head Gallery by Ron Wild and Stephen Morris (UofT) January 29, 2016 Of Maps, Territories and Emerging Patterns, with With Kari Dalnoki-Veress (McMaster)**

Between January 20 and January 30, the Redhead gallery hosted "The Map and the Territory" an exhibition featuring works by Ron Wild and Stephen Morris. These works capture the world as a complicated, yet elegant series of natural, human and technological patterns and networks. The association between these works and the terms named in the title of the exhibition, "map" and "territory" seems obvious. Wild's regular lines and shapes make one think of maps and Morris' meandering formations with their seemingly abstract appearance remind us of a pristine territory to be mapped. However, how can you squeeze these interpretations into established categories, especially when we contemplate them in the space of a gallery? What kind of interpretations, symbols and extrapolations do they evoke? In the end, aren't they all mapping different territories? On January 29, we invited physicist Kari Dalnoki-Veress (Soft Condensed Matter Group, McMaster University) to help us respond to these questions.

March 30th, 2016

*B Beyond Playing. Art-infused games, game-infused art, and disability. With Cindy Porenba (Sheridan College), Anna Lew and Martin Shook (OCADU)*

We are all familiar with the major role that the gaming industry is playing in everyday culture. An increasing variety of games is being created for all audience demographics, with all sorts of purposes in mind: for entertainment, for education, for recruitment etc.. In this special LASER Toronto/ArtSci Salon event, we wish to examine different practices that turn game structures, techniques and imaginary into artistic works, or into discussions on different ability. In both cases, questions of inclusivity and accessibility, assumptions and expectations, aesthetics and taste, collective imagination and social stigma, acquire new meanings, while our attention shifts beyond playing and focuses on larger issues and interests.

May 4th, 2016

#ArtSci: The lab, the studio, the kitchen, the garage. With Nicole Clouston (York University), Jasmine Alkin (DIYBio Toronto)

With the steady growth of citizen science and bioart in the past 15 years, it has become less uncommon to see individuals attempting synthetic biology experiments in their garages and hunting for new antibiotics in their backyards. It is no longer rare for artists to extract DNA in the kitchen or studio and to use bacteria as their artistic medium. Thus, hybrid spaces and hybrid practices are definitely on the rise. This ArtSci Salon addressed what it means to artists and scientists to work in such diverse spaces What are the implications for their work? Are these hybrid spaces encouraging new collaborations?

During the year 2015-16, ArtSci Salon was supported by the Ontario Arts Council and the Fields Institute.

Roberta Buiani (University of Toronto)
Optimization is a rich and thriving discipline rooted in applied mathematics but with high impact applications across all the sciences, engineering, industry and business. Whether one wants to minimize the cost of energy, the weight of an airplane, the efficiency of a chip, the cost of manufacturing, maximize accuracy of engineering design, most efficiently mine massive data sets, or maximize profit, the mathematical way to express one's goal amounts to an optimization problem. Optimization is where mathematics and computing meet to solve problems for high societal impact, including engineering design, optimizing industrial processes, mining huge data sets, optimizing investment portfolios, etc. Some classes of optimization problems are so well understood that problems in millions or even billions of variables are routinely solved on a daily basis; others are so difficult that even small instances can be challenging. This workshop brought together researchers and practitioners from all over the world with a wide variety of expertise from universities and from government and industrial laboratories. It also attracted more than 20 students, postdoctoral fellows and young researchers from all over Canada and the U.S. who presented posters in a well-attended poster session.

The workshop focused on algorithms for solving large-scale continuous optimization problems, both convex and nonconvex, sometimes peppered with integer decision variables, as well as their industrial applications in a variety of contexts. Some talks had a theoretical focus, such as convergence and complexity theory; others had their focus on computational practice, such as efficiency, accuracy, and robustness; finally a significant number of talks offered optimization solutions for problems arising in critical industries, such as smart electricity grids, electricity markets, chip design, optimal oil and gas reservoir management, optimal control of autonomous cars, and financial optimization.

The workshop included 29 plenary and 25 poster presentations covering a broad range of topics according to the scope of the workshop. The first day of the workshop was dedicated to industrial applications. The presentations included: Miguel Anjos (GERAD & Polytechnique Montreal) demonstrated the impact of, and the need for optimization for the emerging Smart Grids; Delphine Sinoquet (Institut Francais du Petrole et Energies Nouvelles, France) presented derivative-free trust region methods for design of mooring lines of floating offshore wind turbines; Bjarne Foss (Norwegian University of Science and Technology) discussed production optimization of offshore oil and gas operations, along with Ulisses Mello (IBM Research, Brazil) who explored optimization challenges in oil/gas reservoir management; Yuying Li (University of Waterloo) presented a novel data mining approach to financial modeling and risk management; Joaquim Martins (University of Michigan) presented the dramatic progress in the area of aircraft wing design via numerical optimization; Marcel Mongeau (ENAC, France) showed the power of continuous and mixed-integer nonlinear techniques for solving aircraft in-flight conflicts; and Chandu Visweswariah (IBM, USA) in an entertaining but enlightening presentation, through case studies from chip design and smarter energy, argued that real life is harder than mathematics. In the lunch break Maplesoft held a demo session, while the posters were presented at the evening reception, after a poster blitz where all poster presenters had 1 minute to present the most important contribution of their research and to entice participants to stop by their posters for more information.
The second and third day of the workshop covered a wide range of algorithmic and computational optimization topics by leading researchers in nonlinear optimization. Presenters came from the US, Canada, UK, France, Portugal, and Belgium. Optimization problems related to the power grid were repeatedly revisited; nonsmooth nonconvex first-order methods were used for sparse signal recovery; factorization-free, variational projection, stochastic Newton and quasi-Newton algorithms, automatic differentiation, and evaluation complexity of nonconvex problems were also presented. The speakers made significant effort to cover the breath of Andrew Conn’s contributions. So, trust region, active set and proximal point methods, derivative-free and space decomposition methods, numerical stabilization and regularization of nonlinear optimization software, and the rapidly growing area of mixed-integer PDE constrained optimization problems were discussed as well. All presentations through the workshop were followed by lively Q&A periods, and discussions continued in the coffee breaks, lunch time, and at the banquet, where Bill Pulleyblank (United States Military Academy) reflected on Andy Conn’s life and numerous contributions to research, to the fabric of the optimization community, and to the economy, both during the first half of his career at the University of Waterloo and the second half at IBM Thomas J. Watson Research Center. Several ad-hoc speakers recalled their interaction with Andy and his wife Barbara, pointed out Andy’s impact on their career and the development of modern nonlinear optimization and its numerous applications in science, engineering, and countless areas of industry.

The workshop provided a fascinating framework to celebrate the 70th birthday of Andrew R. Conn, who, arguably more than anyone, has made major contributions both to the theory and computational practice of nonlinear optimization, as well as to their high impact applications to solve a broad range of industrial optimization problems, such as VLSI design, oil and gas reservoir optimization, and electricity networks. The far reaching influence of Andrew Conn’s contributions was felt throughout the workshop. Many speakers highlighted Andy’s impact on their career, and his path-breaking contributions to the field.

Many peppered their talks with personal stories and emphasized the social aspects of optimization research, and Andy’s and his wife, Barbara’s role in building the optimization community over the past decades.

The organizers are grateful to the following for their financial support: the Fields Institute, for hosting the workshop and funding speakers and poster presenters from Canada, Europe and Brazil; NSERC, whose academic-industrial collaboration program supported the travel costs of four Canadian speakers as well as the costs of lunch and a reception on the first day of the workshop; NSF, whose funds supported the travel costs of speakers and young poster presenters from the U.S.; SIAM and CAIMS, who supported early-career poster presenters from the U.S. and Canada respectively, and both the University of Waterloo and IBM, whose unrestricted funds supported the travel expenses of Andrew Conn and also distinguished senior researcher John Dennis (Rice University), invited to chair the opening session, and a variety of other expenses, including subsidizing the excellent banquet at Le Select Bistro.

Michael L. Overton (Courant Institute of Mathematical Sciences)
Oleksandr Romanko (IBM Canada)
Tamás Terlaky (Lehigh University)
Henry Wolkowicz (University of Waterloo)
ON JUNE 30, 2016, FIELDS HELD A PANEL DISCUSSION on Canada’s innovation gap. Participating were four distinguished panelists: Prof. Vivek Goel (VP Research, University of Toronto), William Janeway (Managing Director, Warburg Pincus), Ilse Treurnicht (CEO, MaRS) and Michael Zerb (Executive VP, Scotiabank). The Honourable Kirsty Duncan, Federal Minister of Science, opened the discussion by making a passionate speech about the importance of science to the future of the country. Minister Duncan also took time to meet many of the scientists attending the panel discussion and praised Fields for its effort on enhancing mathematical sciences research, and promoting diversity in the discipline.

The panel discussion was moderated by Prof. Arvind Gupta, a newly appointed Fields board member. The panel focused on a wide range of topics including the role of venture capital, and the reasons for Canada’s seemingly weak innovation performance. One issue that was raised a number of times was the role of universities and government in preparing the next generation for opportunities in the knowledge economy. There was general agreement by the panelists that while Canada is an international leader in postgraduate education, our PhD trainees do not enjoy the same kind of opportunities as some other OECD countries such as Germany. More specifically, while we are creating more supply, we also need to worry about demand and thus create a more hospitable receptor community for PhDs outside of academia. The discussion concluded that the optimism expressed by Minister Duncan and the new government’s focus on science was a very welcome direction by all participants.

Huaxiong Huang (The Fields Institute)
THEMATIC PROGRAM ON
MULTISCALE SCIENTIFIC COMPUTING
From Quantum Physics and Chemistry to
Material Science and Fluid Mechanics

JANUARY 1 - APRIL 30, 2016
THE FIELDS INSTITUTE

Overview

THE PERIOD FROM JANUARY TO APRIL 2016 WAS marked by the Thematic Program “Multiscale Scientific Computing: from Quantum Physics and Chemistry to Material Science and Fluid Mechanics”. It was organized by Ionut Danaila (Université de Rouen) and Bartosz Protas (McMaster University) as the lead organizers together with Weizhu Bao (National University of Singapore), Qiang Du (Columbia University), Nicholas Kevlahan (McMaster University), Yvon Maday (Université Pierre et Marie Curie), Michael Siegel (New Jersey Institute of Technology) and Lennaert van Veen (University of Ontario Institute of Technology).

The main objective of this Thematic Program was to enable collaboration on a number of related scientific problems, including both long-standing and emerging ones, where advanced scientific computation has made, or is at the cusp of making, important advances. The main themes of the Program were computational methods for the study of (i) extreme, singular and critical phenomena in fluid mechanics, (ii) quantum systems in cold-matter physics and chemistry and (iii) multiscale phenomena in weather, climate and material science. They were selected due to their timeliness and because of the many similarities between the mathematical and computational techniques used in these different fields. Thus, various events of the Thematic Program were planned to allow researchers developing and using similar methods, but belonging to communities working on different problems, to interact with one another. Another recurrent theme of the Program was the interplay between scientific computation and mathematical analysis, where carefully executed numerical computations are used to validate and illustrate the results of rigorous mathematical analysis and to probe new conjectures.

The Thematic Program was organized around three main week-long workshops, each corresponding to one of the three themes. In addition to regular participants, the three workshops attracted many longterm visitors who stayed at the Institute for some time before and/or after the event. A number of program participants were able to attend more than one workshop. Long-term participants of the Thematic Program also included five postdoctoral fellows who were recruited from the Chinese University of Hong Kong (Dr. Dongfang Yun who was named the Fields-Ontario Fellow), Beijing Computational Science Research Center (Dr. Chunmei Su who was named the Marsden Fellow), Université Laval (Dr. Driss Yakoubi) and McMaster University (Drs. Jan Feys and Jamie Foster). Overall, the Thematic Program attracted over 100 participants from across the globe with the following countries being best represented in terms of the number of attendees: USA (35), France (21), Canada (19), UK (11), Germany and Japan (6).

Ionut Danaila and Frédéric Hecht (Université Pierre et Marie Curie) delivered an intense graduate level course on scientific computing which was complemented by a workshop on symbolic computation organized by the representatives of Maplesoft. The Thematic Program also hosted two Public Lectures, by Olivier Pironneau (Université Pierre et Marie Curie) and by Howard Barker (Environment Canada), and in its final week the Program was crowned by the Distinguished Lecture Series presented by Bjorn Engquist (University of Texas, Austin). Highlights of all these events are discussed in more detail below.

This diverse set of activities was complemented by a regular seminar series in Scientific Computing which throughout the duration of the Program provided the venue for program participants to share their work.

As a result, every week from early January until the end of April the Fields Institute was teeming with activities related to the Thematic Program.
**Thematic Program**

**Workshop on Extreme Events and Criticality in Fluid Mechanics: Computations and Analysis**

The main topic of this Workshop was innovative use of large-scale computational techniques to address core problems in theoretical fluid mechanics. Most of the discussions at the Workshop revolved around the questions of regularity and finite-time singularity formation in hydrodynamic models, computation and analysis of transport processes saturating various rigorous bounds, determination of the invariant solutions to the Navier-Stokes system such as the periodic and connecting orbits as well as various scenarios of the laminar-turbulent transition. Evidently, addressing these types of problems usually requires computation of flow solutions characterized by some very special properties such as extremization of certain objective functionals or belonging to some manifolds defined in the solution space. In this sense, these problems reach far beyond the spectrum of problems tackled by traditional Computational Fluid Dynamics (CFD). As discussed at length during the Workshop, the aforementioned questions can be studied by solving suitable variational optimization and fixed-point problems formulated for fluid-mechanics equations.

The solution of these equations poses a tremendous computational task, in some cases far exceeding our current capabilities. Various strategies were discussed which can produce approximate solutions, such as the Large Eddy Simulation (LES), asymptotic expansions and stochastic analysis. One of the highlights of the Workshop, complementing its theoretical and computational aspects, were the presentations by experimentalists studying critical phenomena in fluid mechanics. Masaki Sano and Bjorn Hof presented their independent, experimental confirmations of the universality of the transition to turbulence in shear flows in large domains.

In addition, in the spirit of connecting scientific computations with mathematical analysis, a number of presentations at the Workshop concerned computer-assisted proofs. It was clear from these presentations that this relatively young field of research is steadily moving towards proofs related to analysis of the Navier-Stokes equations. Existence and stability have been proven for equilibria, periodic orbits and connecting orbits for a number of highly nontrivial systems of evolution equations, and fluid dynamics is one of the exciting new challenges.

This breadth of topics was also reflected in the selection of the keynote lectures. Dwight Barkley (Warwick University) discussed mathematical models describing transition to turbulence in pipe flows, whereas Masaki Sano (The University of Tokyo) presented experimental evidence for the universality in the transition to turbulence in channel flows. A survey of recent results concerning singularity formation in 3D Euler flows was the main topic of Tom Y. Hou's (Caltech) presentation. Charles Doering (University of Michigan) spoke of incompressible flows which realize transport of passive scalars in a mathematically optimal way.

**Workshop on Computation of Quantum Systems in Cold-matter Physics and Chemistry**

It was evident from the rich variety of topics presented during this workshop that mathematical modelling and numerical simulations can have a tremendous impact on advancing the knowledge of quantum systems.

Key topics in cold-matter physics (quantum vortices and turbulence, superconductivity, nonlinear waves, etc.) and quantum chemistry (density functional theory, molecular dynamics, solvation models, etc.) were all represented during this 5-day event. The four plenary lectures delivered at the beginning of the morning sessions offered a comprehensive overview the current research frontiers in these fields: quantum hydrodynamics and turbulence in Bose-Einstein condensates were discussed by Makoto Tsubota (University of Osaka), mathematical analysis of models for bosons and fermions was the topic of Eric Cancès (École des Ponts, ParisTech) presentation, nonlinear waves in optics and atomic condensates were discussed by Panos Kevrekidis (University of Massachusetts, Amherst), whereas André Bandrauk (Université de Sherbrooke) presented recent results concerning numerical schemes for the time-integration of Schrödinger-type equations. The plenary lectures were followed by 50-minute talks, arranged so as to alternate topics from quantum physics and quantum chemistry. The workshop had several recurrent themes, including mathematical and numerical analysis of Schrödinger-type equations, bridging the gap between microscopic representations and macroscopic models, and combining deterministic and stochastic models, acceleration of computations using massively parallel architectures, which triggered many informal discussions among the participants of the event. The workshop was therefore an excellent opportunity to foster an exchange of ideas on possible extensions of numerical methods and models developed in one field to another field. There was a consensus among workshop participants about the need for more accurate and efficient numerical approaches if simulations of systems with a very many degrees of freedom are to become possible. When employed in high-performance parallel computations, new mathematical and numerical techniques can reduce the computational time by several orders of magnitude. This trend was illustrated by a number of presentations which concerned applications such as the computation of quantum vortices and turbulence in superfluids, determination of electronic structure in materials and molecular-dynamics simulations in chemistry.

Particular care was taken in the organization of the Workshop to ensure that different points of view and scientific approaches are represented, from mathematical analysis and scientific computation to theoretical physics and chemistry and to industrial applications. This combination of topics generated lively debates and animated exchanges between participants during the coffee breaks and after the sessions.

All the participants, regardless of their experience and seniority, expressed their satisfaction with having learned something new and discovered new ideas related to their research areas during the Workshop.

**Multiscale Modelling and its Applications: From Weather and Climate Models to Models of Materials Defects**

The concept of scale separation has been the key idea in many methods of applied mathematics, from statistical mechanics to quantum mechanics, for over one hundred years. Conventionally, this involved decomposing a physical phenomenon into behaviour on well-separated large and small length scales, or slow and fast time scales. This allows the governing equations to be simplified and solved approximately to high accuracy.

Common applied mathematical techniques using this separation of scales concept include WKB theory, homogenization and rapid distortion theory. The method of multiple scales introduces a hierarchy of slow time scales to extend the validity of an approximation to successively larger times. However, scale separation and multiple scales were not key concepts in numerical analysis and scientific computation until about 30 years ago when Achi Brandt introduced his breakthrough multigrid method for elliptic equations. The multigrid method initiated a burst of interest in numerical methods based on algorithms that decompose a problem into a sequence of grids (or approximation subspaces) at different time or space scales. The structure of the grids may also vary in time and space to give a dynamically or statically adaptive method. 
symbolic computing is an area of scientific computing of ever increasing importance. It is concerned with algorithms for formal manipulation of various mathematical objects such as algebraic expressions, differential equations, etc. Symbolic computation was the topic of the workshop organized by Maplesoft, which is a Waterloo-based company producing the well-known computer algebra package Maple, at the Fields Institute on April 7. The event was run by Daniel Skoog and Austin Roche from Maplesoft and had for its goal to introduce participants to the principles of symbolic computing using Maple as an example.

It consisted of two parts: an introductory session in the morning was aimed at participants with little or no prior knowledge of Maple, whereas the more advanced problem-solving session in the afternoon addressed a selection of questions contributed by participants in advance of the Workshop. The second session resulted in a lively discussion about a number of problems at the forefront of symbolic computing.

The participation of the Maplesoft technical staff, who are directly involved in the development of the software, was key to the success of the event.

The Maple Workshop

More recently, the traditional ideas of scale separation have been extended to a hierarchy of many physical length and time scales, and combined with multiscale numerical techniques, such as multigrid and wavelet methods, to form the new discipline of multiscale modelling.

The physical problem may be governed by the same equations over all scales (such as high Reynolds number turbulence), or it may involve different physics and different equations at different length and time scales (such as both classical and quantum dynamics in materials science, or super-parameterization of cloud physics in climate models). Multiscale models involving different physics at widely varying scales is referred to as “heterogeneous multiscale modelling”. Climate and materials science are two areas that must deal with multiscale and multi-physics phenomenon, but they have each independently developed their own mathematical and computational techniques.

The goal of the third workshop was to bring together climate scientists and materials scientists to present results and exchange ideas on how to model complex phenomena encompassing extreme ranges of length and time scales, and involving different physical phenomena. This gathering of experts from both the climate modelling and materials modelling communities provided a unique opportunity to enhance the development of ideas coming from different applications, but sharing common mathematical and modelling challenges.

In addition to a stimulating series of presentations, the week also included three distinguished lectures by Björn Engquist (University of Texas), described below, which gave a beautiful overview of multiscale computation and heterogeneous multiscale modelling, including examples from both climate and materials science. Howard Barker (Environment Canada) gave well-received public lecture on the importance of multiscale processes, such as cloud physics, in accurate climate and weather models. This public lecture is also described below.

The week ended with a vigorous and animated discussion on themes that had naturally arisen during the workshop. It was striking how similar the basic time/space/scale structure and the challenges (e.g. non-locality, separation/non-separation of scales, extreme events, large deviations and the role of data assimilation) were in both climate and materials research. It was an risky experiment to bring together two groups of scientists in such disparate areas, but the participants found it refreshing and said they gained a new perspective on their own problems and went away with ideas for new approaches.

A culminating event of the third Workshop and of the entire Thematic Program was a series of lectures presented on April 28-29 by Björn Engquist (University of Texas, Austin) on the topic of multiscale computation.

A recipient of numerous prestigious awards and distinctions, Professor Engquist is acknowledged as one of the pioneers of modern multiscale scientific computing. His first introductory lecture surveyed the principles and challenges of multiscale modelling, whereas in the second lecture he presented the “Heterogeneous Multiscale Method” which has already emerged as the computational workhorse for problems involving a combination

Thematic Program

Graduate Course

The course, entitled “An introduction to scientific computing using free software FreeFem++”, was delivered by Professors Ionut Danaila (Université de Rouen) and Frédéric Hecht (University Pierre et Marie Curie), and was attended by 26 registered participants. The course was a graduate-level survey of theoretical and technical aspects of the finite element method. The first week was devoted to elementary concepts (such as building meshes, writing the weak formulation of a PDE problem, imposing boundary conditions) and aimed at mastering the basic mathematics of the method and at developing programming skills with

Fields Institute Thematic Program 5 the FreeFem++ software. The sessions of the second week were devoted to more advanced topics related to the use of the finite element method, namely, approaches for solving nonlinear and 3D PDE problems, mesh adaptivity, moving boundaries and parallel computing. A large variety of model PDE problems was used for illustration — starting from the heat and wave equations, then moving to the equations of the linear elasticity and the Stokes equations, and culminating with the Navier-Stokes-Boussinesq and Schrödinger equations.

On the practical side, the course provided hands-on introduction to the foundations and implementation of numerical algorithms to solve various PDE problems in 1D/2D/3D domains using the finite element method. Each session consisted of a short theoretical presentation of the numerical method, directly followed by its implementation in the form of computer programs. The free software FreeFem++ (www.freefem.org) was used for code development, since it offers a friendly programming environment and has syntax closely resembling the weak formulation of a PDE problem. The course ended with a brainstorming session during which the students presented their own problems and the instructors attempted to provide roadmaps to the numerical solutions of these problems. All the materials from the eight two-hour sessions (lecture slides and computer codes) are now available on-line on the Fields Institute website.

Distinguished Lecture Series: Björn Engquist

Björn Engquist, University of Texas at Austin

A recipient of numerous prestigious awards and distinctions, Professor Engquist is acknowledged as one of the pioneers of modern multiscale scientific computing. His first introductory lecture surveyed the principles and challenges of multiscale modelling, whereas in the second lecture he presented the “Heterogeneous Multiscale Method” which has already emerged as the computational workhorse for problems involving a combination
of models defined at different time- and length-scales. In his final lecture Professor Engquist discussed computational methods for oscillatory systems defined in terms of ordinary differential equations. All the lectures resonated very well with the topics of the third Workshop which had taken place earlier that week.

### Public Lecture Series

The first of the Public Lectures was presented by Professor Olivier Pironneau on March 16 and was entitled “In Search of Optimal Shapes with Mathematics and Computers”. The speaker, who is one of the most prominent computational mathematicians in France, presented a captivating overview of the state-of-the-art computational methods used to solve PDE optimization problems. In such problems one seeks particular input data for the equations, such as the initial and/or boundary conditions, various forms of forcing, etc., so that the solutions will exhibit certain desired properties. Professor Pironneau focused on problems described by PDEs arising in engineering application and discussed how efficient computational optimization algorithms can be derived using formulations based on the calculus of variations. Optimization of “shapes”, such as the shapes of the domains on which the PDE systems are defined, represents a special class of PDE optimization problems whose solution requires additional tools from differential geometry. Professor Pironneau referred to a number of applications to motivate his talk with the most exciting ones representing the design of modern transport airplanes.

The second Public Lecture was presented by Howard Barker (Environment Canada) on April 28 and was entitled “Numerical Prediction of Weather and Climate: From Sub-millimetre Cloud Particles to Global Warming”. Barker is a Research Scientist in the Cloud Physics and Severe Weather Section at Environment and Climate Change Canada. The talk began with a broad overview of weather and climate prediction, in particular the huge gains in prediction accuracy over the last 50 years due to the switch from statistical models to deterministic forecasts based on detailed multiscale physical models, innovative mathematics and advanced computation. He then focused on the quintessential small scale “parametrization” problem: cloud-radiation interactions.

He explained that modelling of cloud particles is responsible for much of the remaining uncertainty in climate models since clouds are primarily responsible for the delicate balance between absorbed and emitted radiation. Barker finished by sketching some of his own research ideas for tackling this problem, and outlining perspectives for the future of climate models.

The talk was well attended, and several members of the public asked penetrating questions about the practical importance of accurate climate modelling.

---

### Final Remarks

The feedback provided by program participants indicates their high level of satisfaction and confirms that the objectives of the Thematic Program were achieved and in some aspects even exceeded, especially as regard jump-starting new collaborations. The Thematic Program is already recognized as a landmark event in its field. Program participants mentioned friendly atmosphere at the Institute and excellent working conditions as key factors contributing to the positive experience, both in scientific and social terms, during their visits. The Thematic Program would not have succeeded without the continuous support provided tirelessly by the staff at the Institute. Generous funding provided for the program by the Fields Institute and the US National Science Foundation is also gratefully acknowledged.

Ionut Danaila (Université de Rouen)
Nicholas Kevlahan (McMaster University)
Bartosz Protas (McMaster University)
Lennaert van Veen (University of Ontario Institute of Technology)
Finally on July 7, 2016, Fields’ own current incubee, Mesh Consultants spoke to conclude the Working Lunch Series for the year. He asked, why can 2D drawings can often communicate far more information in much shorter time, than large 3D data sets? Are there general principles associated with the mechanics of representation that will allow us to communicate our intent more effectively? By studying established theories from the Philosophy of Science and modern User Experience and Interaction Design, he proposed three modes of representation that can be used to create better drawings, better models, and better tools.

### Data Portability in Developmental Services: A Knowledge Sharing Workshop

Robust, convenient and secure methods for storing and sharing information are increasingly important in complex organizations. On March 30, 2016 Fields and Christian Horizons jointly organized The Data Portability Workshop In Developmental Services. It was a day-long symposium on how to make information transfer easier within the Developmental Services sector. Topics touched on the challenges, strategies and best practices for how data is shared both inside and outside Developmental Services organizations. The workshop included interaction between academic community, Ministry of Community and Social Services, industry and agencies within the sector. Expert talks were held in the morning and several breakout sessions occupied the afternoon. The day provided valuable insight and generated new ideas on how to design and implement a protocol for information transfer.

### 2016 Industrial Problem Solving Workshop

Though many events are held throughout the year, the flagship event for the CIM is the week long Industrial Problem Solving Workshop (IPSW) held at Fields in August. The IPSW occurred over 5 days from August 15-19, 2016. Participants included a group of academic experts (including mathematicians and statisticians) as well as experts from industry. On the first day, the industrial sponsors presented their problem statements. After which the academic experts divided into small teams, with one team assigned to each problem.

The teams spent the next 3 days collaborating on solutions to their problem, and presented their solution on the final day of the workshop. This interaction between industry and academia has many benefits for both. Academics learn about interesting potential research problems and and application for their existing tools. Industries get access to some of the most experienced mathematical modellers and problem-solvers on the continent. At the end of the week, the academic experts make a presentation consisting of the problem restatement and their solution.

---

**THE GOAL OF THE COMMERCIAL and Industrial Mathematics Program (CIM)** is to increase the collaboration and interaction between academia and industry in the mathematical sciences throughout Canada. The 2015 - 2016 academic calendar was a very busy time for CIM. Over the course of the year its many activities focused on three main areas: Seminars and Conferences, Education and Career Training as well as Entrepreneurship and Incubation.

### Seminars and Conferences

The seminars and conferences organized by the CIM bring industry and academia together to discuss mutual challenges, possible solutions and future research initiatives.

### The Working Lunch Seminar Series

The ongoing Working Lunch Seminar Series provides a casual, discussion type atmosphere where companies can present the issues that they are facing to an assembled group of academics and other industry experts. Attendees enjoyed a catered lunch and stimulating conversation.

The speaker for the first Working Lunch seminar, on September 29th, 2015, was Shiva Amiri from Real Time Data Solutions. In her talk she discussed a tool developed by RTDS Inc. called SymetryMLTM, which is a technology for zero latency machine learning and analytics of very large datasets in real time, with a focus on speed, accuracy and simplicity. Originally developed and used successfully in the mobile advertising space, RTDS Inc. is now exploring new verticals with this technology. Examples of the use of this technology were given in three different verticals: 1- biomedical informatics (brain data, molecular dynamics simulations, and genomics), financial modeling, and 3 – the Internet of Things. The complexities and lessons learned from these verticals were discussed as her thoughts about what future research in the space could look like.

On December 8, 2015, Fields welcomed Quito Maggi from Mainstreet Research to speak at the Working Lunch. He talked about the challenges facing pollsters today as Canadians change the way they live their lives, as well as the challenges still to come.

The recent advancements in Machine Learning fueled by large amounts of data and cheap computational power have opened interesting opportunities for innovation in the consumer product space. On January 26, 2016, Renat Gataullin came to Fields to talk about challenges and applications of Machine Learning at 500px.

The fourth Working Lunch seminar was given on May 5th, 2016 by Suhaill Shergill from Yellow Pages. He considered some specifics of auction networks and draw some connections to related domains such as financial trading. Specifically some of the manual decisions which are made in the course of optimizing advertising campaigns, and discuss what can be done to automate them.

The Working Lunch Seminar Series was given on May 5th, 2016 by Suhaill Shergill from Yellow Pages. He considered some specifics of auction networks and draw some connections to related domains such as financial trading. Specifically some of the manual decisions which are made in the course of optimizing advertising campaigns, and discuss what can be done to automate them.

---

**THE FIELDS INSTITUTE for Research in Mathematical Sciences | FIELDSNOTES 23**
Problems submitted to the 2016 IPSW included:

- Determining the Failure of Fontan Circulation at an Earlier Time Point than Current Clinical Approaches - Toronto General Hospital
- Predict Licensability of Photos - 500px Inc.
- Setting station targets for better bike share service levels - Hamilton Bike Share Inc.
- The Mathematics of Polling - MainStreet Research
- Separating noise from the electroencephalography (EEG) signal towards predicting from EEG a clinical phenotype - CAMH
- Dynamic Valuation of Pledged Securities - TMX
- Combining Two Relative Rankings of Credit Risk Into One Ranking - Scotiabank

Education and Career Training

Another focus of the CIM is to provide students and graduates in the mathematical sciences with relevant training and education to enhance their career opportunities in industry.

Tools for Data Scientists

With the growing amount of data generated in virtually every sector, handling and interpreting large data sets is increasingly being seen as a value proposition for a considerable number of industries. Part statistician, part mathematician, and part computer scientist, the role of Data Scientist within these industries is becoming increasingly prominent, however few tools exist to handle data of very large magnitude. Over the course of a few months, Fields hosted training events for some of these tools.

From February 17th to February 19th, 2016 The Fields Institute hosted a three day workshop on parallel computing led by A.J. Guillon, a world expert in the field. The training provided attendees with a mixture of theory and hands-on experience. Participants learned parallel programming with OpenCL, and so will now be able to apply their knowledge to CPUs, GPUs, FPGAs, and other accelerators such as the Intel Xeon Phi.

Just over a month later, on March 22, 2016, IBM came to Fields for The Watson Analytics Hands-On Workshop. The workshop was designed for professors and students as a way to introduce them to the revolutionary approach to analytics that is smart data discovery. The workshop was open to all students and faculty who worked hands-on with the software and discovered the power of combining data from Twitter, Cognos Enterprise Reporting systems, standard relational databases and cloud data storage sources. SymetryML, proprietary software from Real Time Data Solutions, leverages Apache Spark to quickly process large datasets, generating GPU-implementable predictive models with zero rescan, thus requiring little to no latency in model updating. In the hands-on workshop held on June 29, 2016 they covered basic use of SymetryML TM through both the web user interface and the Python API. They also and provided an overview of their current efforts in applying this technology to suit specialized problems in health, finance, and the internet of things.

Career Events

On October 5, 2015, John Hull, Carlos Martinez Amaya, David Milne, Paolo Sironi, Michael Zerbs engaged in a panel discussion titled “How I Became a Quant: Financial Engineers Give a Personal View of their Careers in Quantitative Finance.” They shared their insights on the industry, and afterwards students were able to meet with recruiters such as Scotiabank, KPMG, and S&P Capital IQ.

Entrepreneurship and Incubation

In 1999, Fields began a program to foster start-up companies that commercialize innovations which have substantial mathematical foundations. The program has an impressive track record of success, fostering companies from a wide range of areas including companies in the financial technology sector, mathematics education, cryptography. More recently the incubation program has expanded to include Mesh Consultants, a company specializing in combining geometry, architecture, construction and technology and optimization. The incubation program continues to be unique among mathematics institutes worldwide.

On October 1st, 2015, The Fields Institute held “Innovation Day” and invited leaders from all of its incubated companies, along with a panel of international experts, to share their experiences and discuss mathematical innovation. Focused on bringing together the University of Toronto’s entrepreneurial talent and developing important networks for our entrepreneurs and faculty, “Phase Next: Beyond the Prototype” was organized by The Banting and Best Institute and hosted at Fields. It provided participants the opportunity to connect with:

- Entrepreneurial mentors and successful industry professionals
- Some of U of T’s best and brightest entrepreneurs
- University faculty and post-docs interested in converting their research into commercial products and services.

The CIM is looking forward continuing and expanding each of these initiatives in the coming 2016-2017 academic year, while expanding the program into new and exciting areas.

Tyler Wilson (Fields)
**GENERAL SCIENTIFIC ACTIVITIES***

**JULY - DECEMBER 2016**

**JULY 5 - 8, 2016**
WORKSHOP ON REDESIGNING THE HIGH SCHOOL MATH CURRICULUM
QUEEN'S UNIVERSITY

**JULY 6 - 8, 2016**
16TH CANADIAN CONFERENCE ON GENERAL RELATIVITY AND RELATIVISTIC ASTROPHYSICS
SIMON FRASER UNIVERSITY

**JULY 7 - 8, 2016**
PRE-WORLD CONGRESS MEETING OF NEW RESEARCHERS IN STATISTICS AND PROBABILITY
THE FIELDS INSTITUTE

**JULY 7 - 8, 2016**
DIRECTED GRAPHS CONFERENCE
UNIVERSITY OF WATERLOO

**JULY 11 - 15, 2016**
WORLD CONGRESS IN PROBABILITY AND STATISTICS
THE FIELDS INSTITUTE

**JULY 11 - 15, 2016**
CONFERENCE ON GROUP ACTIONS AND ALGEBRAIC COMBINATORICS
HERSTMONUCEUX CASTLE, UK

**JULY 13 - 17, 2016**
2016 CANADIAN UNDERGRADUATE MATHEMATICS CONFERENCE
UNIVERSITY OF VICTORIA

**JULY 16 - 18, 2016**
WORKSHOP ON MILESTONES IN COMPUTER ALGEBRA
UNIVERSITY OF WATERLOO

**JULY 18 - 22, 2016**
CONFERENCE ON GEOMETRY, REPRESENTATION THEORY AND THE BAUM-CONNES CONJECTURE
THE FIELDS INSTITUTE

**JULY 19 - 22, 2016**
INTERNATIONAL SYMPOSIUM ON SYMBOLIC AND ALGEBRAIC COMPUTATION (ISSAC 2016)
WILFRID LAURIER UNIVERSITY

**JULY 25 - 29, 2016**
NEW TRENDS IN APPROXIMATION THEORY
THE FIELDS INSTITUTE

**JULY 25 - 29, 2016**
WORKSHOP ON INTERACTIONS BETWEEN MODEL THEORY AND ARITHMETIC DYNAMICS
THE FIELDS INSTITUTE

**AUGUST 2 - 6, 2016**
WORKSHOP ON MODEL THEORY: FROM FIELDS TO HARDY FIELDS
THE FIELDS INSTITUTE

**AUGUST 3 - 5, 2016**
CANADIAN CONFERENCE ON COMPUTATIONAL GEOMETRY 2016
SIMON FRASER UNIVERSITY

---

**THEMATIC AND FOCUS PROGRAMS**

**2016 -2017**

**JULY - DECEMBER, 2016**
THEMATIC PROGRAM ON COMBINATORIAL ALGEBRAIC GEOMETRY

**AUGUST, 2016**
FOCUS PROGRAM ON TOPOLOGY, STRATIFIED SPACE AND PARTICLE PHYSICS

**JANUARY TO JUNE, 2017**
THEMATIC PROGRAM ON UNLIKELY INTERSECTIONS, HEIGHTS, AND EFFICIENT CONGRUENCING

**MAY – JUNE, 2017**
FOCUS PROGRAM ON RANDOM GRAPHS AND THEIR APPLICATIONS TO COMPLEX NETWORKS

**JULY - AUGUST 2017**
FOCUS PROGRAM ON NONLINEAR DISPERSIVE PARTIAL DIFFERENTIAL EQUATIONS AND INVERSE SCATTERING

**JULY - DECEMBER, 2017**
THEMATIC PROGRAM ON GEOMETRIC ANALYSIS

FOR MORE INFORMATION ABOUT OUR ACTIVITIES, PLEASE VISIT WWW.FIELDS.UTORONTO.CA/ACTIVITIES/THEMATIC-AND-FOCUS-PROGRAMS

* THE GENERAL SCIENTIFIC ACTIVITIES POSTER CAN BE DOWNLOADED FROM THE FIELDS INSTITUTE WEBSITE

THE FIELDS INSTITUTE for Research in Mathematical Sciences | FIELDSNOTES 25
CALL FOR PROPOSALS, NOMINATIONS, AND APPLICATIONS

For more information about Fields Institute proposals, nominations, or applications, please visit our website: www.fields.utoronto.ca/proposals

THEMATIC AND FOCUS PROGRAMS
The Fields Institute solicits proposals for a variety of programs in areas of current research interest in the mathematical sciences: (1) Major thematic programs, six months in length. (2) Thematic or focus programs, from one to two months in length to run concurrently with our major thematic programs; in particular, two-month summer programs of an interdisciplinary nature. Proposals or letters of intent should be submitted by March 15 or September 15, with a lead time of at least two years recommended for six-month programs.

GENERAL SCIENTIFIC ACTIVITIES
Proposals for short scientific events in the mathematical sciences should be submitted by October 15, February 15, or June 15 of each year, with a lead time of at least one year recommended. Activities supported include workshops, conferences, seminars, and summer schools.

OUTREACH PROPOSALS
The Fields Institute provides support for projects whose goal is to promote mathematical culture at all levels and bring mathematics to a wider audience. Faculty at Fields sponsoring universities or affiliates are invited to submit a proposal to the Fields Outreach Competition. There are two submission deadlines each year, June 1 and December 1. Proposals should include a detailed description of the proposed activity and the target audience. A budget indicating other sources of support is also required.

FIELDS INSTITUTE FELLOWS
This is a call for nominations for the Fields Institute Fellows. To nominate someone, please send a CV plus a letter briefly outlining why your candidate is a worthy nominee, to proposals@fields.utoronto.ca, or to:
The Director
Fields Institute
222 College Street, Second Floor
Toronto, Ontario M5T 3J1, Canada

Winners of the CRM-Fields-PIMS prize are automatically recommended for fellowship. No member of the current Fields Institute Board of Directors nor any continuing member of the Fields Institute Scientific Advisory Panel will be eligible. Nominations are encouraged from all qualified individuals, including women, members of visible minorities, and persons with disabilities.

THE DEAN'S DISTINGUISHED VISITING PROFESSORSHIP
The Dean's Distinguished Visiting Professorship is a joint program of the Fields Institute with the Faculty of Arts and Science, and the Department of Mathematics of the University of Toronto. Each year, the program brings a leading international researcher in the mathematical sciences to give a full-term course connected to a Fields Institute program, for graduate and advanced undergraduate students of the University of Toronto and other students participating in the program.

The Dean's Distinguished Visiting Professorship currently provides a stipend of $50,000, for a visitor to be in residence throughout a term. The Dean's Distinguished Visiting Professor is selected by a committee representing the Fields Institute and the Department of Mathematics. Nominations can be made either to the Director of the Institute or to the Chair of the Department of Mathematics.

THE MARGARET SINCLAIR MEMORIAL
The Margaret Sinclair Memorial Award recognizes an educator in Canada who has demonstrated innovation and excellence in promoting mathematics education at the elementary, secondary, college or university level. This annual award will be administered by the Fields Institute for Research in Mathematical Sciences and comprises a $5000 prize and inscription of the winner's name on a plaque to be installed at the Fields Institute recognizing the recipients. Candidates for the award will have shown an enthusiasm for enhancing the learning environment and displaying novel ideas, methods or devices for teaching mathematics. They will also have supporting evidence of providing an opportunity for students to achieve, observe, and experience mathematics in a thoughtful and significant way.

Creative leadership is also an important factor. Candidates must have served as a role model for other teachers and had an inspirational influence on students and/or colleagues. This may have been displayed through meaningful classroom teaching, directing mathematical forums, encouraging rational and critical discussions while using accurate data to support one's position, fostering teamwork, writing effectual curriculum support materials, contributing to mathematics education journals, or being involved as an organizer or speaker at mathematics education meetings or conferences.

Candidates for the award may nominate themselves or be nominated by others.

A complete nomination packages consists of:
1. A nomination letter of no more than 1000 words demonstrating alignment with The Margaret Sinclair Memorial Award
2. A recent curriculum vitae
3. Three (3) letters from arm's length referees

Nominations for the 2017 Margaret Sinclair Memorial Award must be received electronically by the Fields Institute by December 1, 2016. Send to deputydirector@fields.utoronto.ca

Please note that nominations for the Margaret Sinclair Award will be kept under consideration for two additional years following the initial submission.

POSTDOCTORAL FELLOWSHIPS
The Fields Institute's Postdoctoral Fellowships provide for a period of research activity at the Institute and participation in our programs. We are currently soliciting applications for Fields Postdoctoral Fellowships and Jerrold E. Marsden Postdoctoral Fellowships. Qualified candidates who will have a recent PhD (normally awarded not more than five years before tenure of the Fellowship) are encouraged to apply.
CALL FOR PROPOSALS, NOMINATIONS, AND APPLICATIONS CONTINUED...

FIELDS RESEARCH FELLOWSHIP

This fellowship provides an opportunity for a period of full-time “Research in Residence” at the Fields Institute. Faculty members at our Principal Sponsoring Universities are invited to apply (e.g. for a period during a research leave from their own university), or to nominate a mathematical scientist for the purpose of collaborative research.

Fellowship holders will be provided with office space, access to all Fields facilities and activities, and an allowance for living expenses up to $3500 for each month of full-time residence. The minimum length of residence is 1 month, and the maximum length normally 3 months. Note that faculty living in the GTA are not eligible to hold the fellowship, but may nominate external candidates for the award.

Selection of successful candidates will be made by the Directors of the Institute, in consultation with the Scientific Advisory Panel.

There are no restrictions on the nationality of the candidates. In accordance with our mandate, the Fields Institute encourages applications from women and under-represented groups.

All application materials should be sent by email to director@fields.utoronto.ca at least 3 months prior to the proposed start date. The annual application deadlines are September 15, January 15 and May 15.

FIELDS PUBLICATIONS

The Fields Institute publishes two book series, the Fields Institute Communications and the Fields Institute Monographs. Publications in both series often result from activities at the Institute, but we encourage all authors of books to consider publishing with us. Our publishing program with Springer affords authors the advantages of wide distribution and advertising, high quality, digital versions, and a guarantee that all volumes will remain in print indefinitely.

The Communications Series consists of conference proceedings of research and survey articles. The Monograph Series features high-quality research monographs and lecture notes in mathematics and applications of mathematics in science, engineering, finance, industry and medicine. From 1993 to 2011, 61 Communications volumes and 28 Monographs volumes were jointly published with the American Mathematical Society and are available through the AMS online bookstore. Since January 2012, these book series have been published with Springer.

The acting Managing Editor of our publications is Huaxiong Huang - hhuang@fields.utoronto.ca

FIELDS PERIMETER AFRICA POSTDOCTORAL FELLOWSHIP

The Fields Institute for Research in Mathematical Sciences and Perimeter Institute for Theoretical Physics are inviting applications from African Nationals for a one-year Joint Postdoctoral Fellowship. The deadline for applications to the 2016 Fields-Perimeter Africa Postdoctoral Fellowship will be November 15, 2016.

Applications are accepted through Mathjobs: www.mathjobs.org/jobs/jobs/5691
The Symposium will be centered on the work of Manjul Bhargava (Fields Medal 2014), and its current and potential impact. The scientific program is aimed at a wide audience, including graduate students, mathematicians in other research areas, and scientists who use mathematics in an important way. The Symposium will feature a public lecture by Manjul Bhargava on November 1, 2016, and a special networking event with Professor Bhargava for high school and undergraduate students on November 2, 2016.

For more information, please visit:
http://www.fields.utoronto.ca/activities/16-17/fieldsmedalsym